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# **Investigating the Effectiveness of Educational Interventions to Reduce Disgust towards Insect containing Food**

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A dissertation submitted to the University of Bristol in accordance with the requirements for  
award of the degree of Masters by Research in the Faculty of Life Sciences

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## Abstract

Insects are a more sustainable and nutritious alternative to conventional livestock. However, insect consumption is perceived as disgusting among the Western population. Over two experiments, this project aimed to test the effectiveness of educational information to overcome disgust towards falafels participants believed contained mealworm flour. This project was novel as food intake was measured and disgust was measured implicitly. In Experiment One a method to induce mild Threat was developed for use as an emotional control condition in Experiment Two. The *expectation* of a tongue biopsy was the chosen method. In Experiment Two participants ( $n = 104$ ) were divided equally between four conditions that each had a unique passage: 1) Control – participants informed falafels contain new spices + neutral information, 2) Mealworm – participants informed falafels contain mealworm flour + neutral information, 3) Mealworm + education – participants informed falafels contain mealworm flour + educational information (outlining environmental and nutritional advantages of mealworm consumption), 4) Threat – participants informed falafels contain new spices + tongue biopsy threat. Importantly, the falafels were the same for all participants and did not contain mealworm flour. Disgust was measured using: tactile sensitivity, liking for and desire to eat falafels, latency to eat and falafel intake. Contrary to prediction, participants in the *Mealworm + education* condition showed significantly greater disgust (lower liking, desire to eat and intake) than those in the Control condition, whereas these measures did not differ significantly between the Control and Mealworm conditions. These findings are attributed to the Mealworm passage normalising the cooking of mealworms and increasing their familiarity by describing how they are turned into ‘flour’, while the rational arguments included in the Mealworm + education passage were insufficient to reduce the deep-rooted, irrational, disgust response. Results of this study suggest that using rational educational arguments to reduce insect-food disgust is relatively ineffective.

## **Dedication and Acknowledgements**

I am very grateful to my supervisor Professor Peter Rogers for guiding me through this degree. I have thoroughly enjoyed learning a wide array of key research skills from such an experienced, and knowledgeable, academic. I have appreciated his openness to my ideas and introducing me to the world of academia. I would also like to thank Dr David Hunt for sharing his knowledge with me and teaching me how to take tactile sensitivity measures.

My undertaking of this research degree would not have been possible without the unfaltering support of my parents, so this degree is dedicated to them.

## **Author's declaration**

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: .....Maya Gumussoy..... DATE:.....13/06/2019.....

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**LtE** – Latency to Eat

**NBU** – Nutrition and Behaviour Unit

**DtE** – Desire to Eat

**DEBQ** – Dutch Eating Behaviour Questionnaire

**DS-R** – Disgust Scale-Revised

**FTN** – Food Technology Neophobia



## **1. General Introduction**

The issue of climate change has become more apparent in recent years with the emergence of the IPCC (Intergovernmental Panel on Climate Change) report which emphasised the need to reduce carbon dioxide emissions by 45% by 2030 (Masson-Delmotte et al., 2018). Current livestock rearing practices significantly contribute to climate change. Therefore, sustainable protein sources and production practices need to be identified – entomophagy (the consumption of insects as food) could be the answer (Nadeau, Nadeau, Franklin, & Dunkel, 2015). However, the emotion of disgust acts a large barrier to entomophagy in the Western culture (Cicatiello, De Rosa, Franco, & Lacetera, 2016; Menozzi, Sogari, Veneziani, Simoni, & Mora, 2017; Ruby, Rozin, & Chan, 2015) – interventions to overcome this need to be developed.

### **1.1 Why we should eat insects**

#### **1.1.1 Environmental sustainability.**

Current meat production practices are not sustainable. Population growth and rising incomes will lead to a 75% increase in the demand for meat products by 2050 (van Huis & Oonincx, 2017). This is problematic as livestock rearing is the third largest contributor to severe environmental problems (Steinfeld et al., 2006). It is the largest anthropogenic use of land which leads to deforestation and 18% of greenhouse gas emissions are due to the livestock sector - this is more than the transport sector (Steinfeld et al., 2006). In order to increase the sustainability of food production, consumption of conventional meat (e.g. beef, pork, lamb, chicken) needs to be reduced (Aiking, 2011; Leip et al., 2015).

In recent years the rearing of insects for human food has been proposed as a more sustainable alternative to conventional meat (e.g. van Huis et al., 2013). A recent life cycle assessment showed that the production of insect based protein powder is 25 times more sustainable than conventional protein products (Smetana, Palanisamy, Mathys, & Heinz, 2016). Another life cycle assessment conducted by Oonincx & de Boer (2012) found that 1 kg of edible protein from milk, chicken, pork and beef produced higher emissions of greenhouse gases, required similar amounts of energy, but more land, than 1 kg of edible protein from mealworms – mealworms are therefore a more sustainable source of protein. It is worth noting that the environmental impact from red meat such as lamb, beef and pork is substantially (up to 150%) more than the environmental impact of white meat such as chicken and white fish (Hamerschlag & Venkat, 2011; Hoolohan, Berners-Lee, Mckinstry-West, & Hewitt, 2013). Insects can be reared on agricultural by-products and food waste thus reducing the need for high energy inputs for their rearing (Alexander et al., 2017; van Huis et al., 2013). Another key advantage of insect production is their high feed conversion efficiency, compared to many conventionally consumed animals, due to being cold blooded (van Huis, 2015, 2016; van Huis & Oonincx, 2017). Feed conversion efficiency further reduces the energy input required for insect rearing and emphasises their environmental superiority over conventional meat production.

### **1.1.2 Nutrition.**

Many insect species are highly nutritious (Sun-Waterhouse et al., 2016), arguably more so than conventional proteins. Protein, and indispensable amino acid content, can vary a lot between insect orders (Churchward-Venne, Pinckaers, Van Loon, & Van Loon, 2017), but their protein is highly digestible (Belluco et al., 2013). Many provide the required

daily amounts of indispensable amino acids as well as zinc and vitamin B12 (DeFoliart, 1992; Nadeau et al., 2015). It is not uncommon for insects to contain high amounts of fibre as their exoskeleton is made from chitin, as well as adequate levels of unsaturated fats (DeFoliart, 1992; Kouřimská & Adámková, 2016). Mealworms, specifically, have similar amounts of unsaturated omega-3 and 6 fatty acids, protein, vitamins and minerals to that in fish and meat (van Huis et al., 2013).

### **1.1.3 General advantages of entomophagy.**

Their high nutritional value, and ease of rearing, make insects a potential key contributor to food security (Belluco et al., 2013; Churchward-Venne et al., 2017). They also pose a much smaller risk of transmitting zoonotic infections as they are taxonomically very distinct from humans, much less so than current conventional meat (van Huis et al., 2013).

A feasible alternative to consuming insects could be adhering to a vegetarian or vegan diet. By removing the consumption of meat, these diets have the advantage of reducing climate change caused by the livestock sector and may be preferred to a diet including entomophagy among Western people. However, entomophagy offers advantages beyond a diet free of meat (vegetarian diet) or all animal products (vegan diet).

Firstly, many insects are highly palatable so are an enjoyable part of the diet. For example, the witchetty grub, consumed by Aboriginal people in Australia, is known for its nutty taste and crispy texture once cooked (van Huis et al., 2013). The taste of some insects is their main appeal among those who consume them. In the city of Kinshasa (the capital of the Democratic Republic of Congo) 70% of the eight million population consume caterpillars because of their taste as well as their nutritional value.

Due to their high nutritional value insects could play a role in reducing undernutrition in some areas of the world – hence the importance of increasing their consumption. While this is mainly due to being nutritious, insects are particularly beneficial for combatting undernutrition because they do not require specialist equipment, excessive space or feed to rear (Ramandey and van Mastrigt in Durst, Johnson, Leslie, & Shono, 2010; Nadeau et al., 2015). Therefore, insects can be reared by those who are relatively lacking in money and resources and consequently also at a higher risk of undernourishment.

In comparison, while the vegan and vegetarian diets have the benefits of reducing BMI, cholesterol (Key, Appleby, & Rosell, 2006), heart disease and diabetes, it is advised that those following these diets supplement their food with vitamins B12 and those following the vegan diet supplement with calcium in addition, as these compounds are rare, or not found, in non-animal products (Craig, 2009). While this lifestyle is possible among those who are affluent and educated on the matter, it may not be a realistic expectation for those who live in more rural settings where nutritional education is less common and supplements are unavailable, if not too expensive. Therefore, insects pose the unique advantages of the potential to reduce hunger by providing adequate nutrition, being oro-sensorially appealing, being cost effective and feasibly grown (Nadeau et al., 2015). These advantages go beyond those associated with the vegetarian and vegan diets though those diets are still highly advantageous in certain contexts.

## **1.2 Disgust towards entomophagy**

The aversion towards insects as food in the West perhaps began due to reliance on an area of land south of Europe known as ‘The Fertile Crescent’. Here, the environment

supported the domestication of large livestock and plants which led to these being dominant in the European diet. Insects were consequently seen as pests and a threat to food production (DeFoliart, 1999; Diamond & Ordunio, 1999). This attitude may have led to those living in The Fertile Crescent feeling the emotion of disgust which is said to be a basic emotion (Darwin, 1872), along with fear, anger, sadness, enjoyment and surprise (Ekman, 1992).

Disgust is the emotion that limits entomophagy. In the context of food, it is defined as “revulsion at the prospect of (oral) incorporation of an offensive object” (Rozin & Fallon, 1987, p. 23). Rozin and Fallon (1987) claim there are four types of food rejection: Disgust, Distaste, Danger and Inappropriate. Disgust reactions are characterised by a combination of distaste and ideational factors (knowledge that makes the food be perceived as Inappropriate). This means the item is rejected due to being sensorially offensive and, based on knowledge of the origin of the item, not appropriate to ingest, respectively. The aversion to insect consumption most closely aligns with food rejection based on Disgust as insect aversion is often culturally bound and socialised to members of the social group (Herz, 2012), which requires a level of knowledge of what is appropriate to eat. This is demonstrated by children under the age of eight describing the rejection of eating a grasshopper being based on Danger (ingestion could cause harm) or Distaste (item is sensorially offensive). After the age of eight, when they have knowledge to support ideational factors, they reject it simply because “it’s a bug”. Others have also argued that insects are seen as part of the same construct as pathogens and are viewed as disgusting on this basis (Lorenz, Libarkin, & Ording, 2014).

Disgust, as an emotion, has been extensively studied in the past and recently the connection between disgust and tactile (touch) sensitivity was investigated. The immune system is complemented by a behavioural immune system which includes psychological mechanisms that elicit avoidant emotions and behavioural responses in the presence of pathogens/disease threats (Schaller & Park, 2011). Skin is part of the immune system, so it is likely to have a behavioural aspect to enhance its functioning. Therefore, when disgust evoking stimuli or threats of disease are present, tactile sensitivity might be enhanced in order to aid detection and protect the self. This enhancing of tactile perception is not in-keeping with the effect of disgust on other forms of perception – it has been established that disgust generally acts to reduce perception as a way to avoid the disgust inducing stimulus (Susskind & Anderson, 2008; Susskind et al., 2008). In a recent study, participants in a ‘disgust’ condition were shown a video of live maggots and their tactile sensitivity measured. Results showed an increase in tactile sensitivity among this group compared to a control group and a ‘threat’ group (included to control for general negative arousal; Hunt et al., 2017). If insects are seen as the same construct as pathogens, as suggested by Lorenz, Libarkin and Ording (2014), then tactile sensitivity may increase in response to insects. Using tactile sensitivity to measure disgust towards insects could be very insightful as it is an implicit measure and therefore not constrained by the issues associated with explicit self-reports, such as the influence of demand characteristics on participant responses. Using tactile sensitivity as a measure of disgust response has the advantage of relative practical simplicity in comparison to other physiological measures such as skin conductance measures and heart rate variability. There is also some evidence that skin conductance responses to threat and disgust do not oppose (Kreibig, 2010) which may make its ability to distinguish between these emotions weaker.

Disgust is very understudied in relation to its role in food rejection. Few studies measure disgust in relation to food, and those that do have generally measured the *trait* of disgust sensitivity (e.g. Hartmann & Siegrist, 2016; Siegrist & Hartmann, 2019), or simply asked participants to *self-report* how disgusted they feel (e.g. La Barbera, Verneau, Amato, & Grunert, 2018; Verneau et al., 2016). This is therefore a gap in the research area that needs to be addressed.

### **1.3 Emotion induction**

The methods used to induce disgust and threat in Hunt et al's (2017) study were showing participants videos of maggots and riots respectively – both were effective. The 'threat' condition was included because negative emotions such as disgust, distaste, threat and anxiety produce similar, but subtly different, physiological responses in humans (Kreibig, 2010). Therefore, any negative affect associated with disgust could become confounded with negative emotions other than disgust itself. As the threat condition was included in Hunt et al's (2017) study, if different patterns emerged then it could be concluded more confidently that changes in tactile sensitivity were due specifically to the emotion of disgust and not negative affect more generally – as was found to be the case. The use of threat as the general negative arousal control is logical because disgust and fear (a more general form of threat) are both basic emotions (Ekman, 1992) making them suitable controls for each other.

A previous study investigating an evolutionary theory relating to tactile sensitivity changes in response to fear found that tactile sensitivity *decreases* in response to fear. Over two studies fear, anger and neutral affect were induced using an emotional memory task

and emotion inducing pictures. Tactile sensitivity (measured using two-point discrimination on the fingertip) was found to decrease in the fear condition compared to the anger and neutral conditions. This finding supports the presence of advantageous mechanisms that redirect blood flow to the central nervous system and visual areas, at the expense of tactile sensitivity (Kelley & Schmeichel, 2014). The inclusion of the anger condition in this study was to act as a negative emotional control, similar to the threat condition in the Hunt et al., (2017) study. Determining methods to induce negative emotions can be difficult, and ethically complicated, but it is important to isolate the effect of the target emotion. This issue was the motivation behind the design, and inclusion, of Experiment One in the present project.

#### **1.4 Attempts to increase entomophagy**

Due to the widespread advantages of entomophagy, such as being environmentally sustainable and highly nutritious, there is a wealth of research investigating possible methods to increase acceptance (willingness to consume/attitudes) of insect consumption in the West.

##### **1.4.1 Familiarity.**

Some authors argue that the perception of insects as unfamiliar needs to be reduced. This claim is based on the results of a study showing that participants were more willing to consume processed crickets incorporated into a cookie, than an unprocessed whole cricket (Hartmann, Shi, Giusto, & Siegrist, 2015). This finding led to the recommendation of incorporating insects into familiar food items in order to reduce



neophobic responses towards them. Similarly, an online survey showed that among 820 consumers, insects that were incorporated into familiar food products, such as a biscuit, were more appealing (Wilkinson et al., 2018). These findings are supported by conclusions that people in the West are not ready to eat insects in their whole form so they should be ground into powder form and incorporated into familiar, ready to eat meals (Caparros Megido et al., 2016), and incorporated into typically Western foods, such as bakery products (Menozzi et al., 2017). However, other authors argue that incorporating insects into foods that individuals are already familiar with, will inevitably lead to disappointment as the novel ingredient will lead to a sensory change in the familiar food and the food will be rejected due to oro-sensory dissatisfaction (Tan, Tibboel, & Stieger, 2017; Tan, Verbaan, & Stieger, 2017) i.e., distaste.

#### **1.4.2 Sensory appeal.**

Some authors have argued that emphasising, and enhancing, the sensory appeal of insect ingredients will lead to increased acceptance (e.g. Hamerman, 2016; Myers & Pettigrew, 2018; Shan et al., 2015). Deroy, Reade and Spence (2015) argue that taste preferences drive food choice so strategies to increase entomophagy need to be sensorially driven. Information campaigns could emphasise the oro-sensory attributes of insects (Sogari, Menozzi, & Mora, 2018) and ideally include input from gastronomical science (Sogari, Menozzi, & Mora, 2017).

#### **1.4.3 Cooking.**

Other authors have emphasised the importance of the cooking process to increase the acceptance of insect consumption. Cooking is a very important process, particularly for animal ingredients as it transforms them from being raw, unappetising and potentially

harmful, into edible items that are perceived as food (Hamerman, 2016). One study found that those who read a cooking prime were more willing to attend an event where insect food would be served (Hamerman, 2016). Another study concluded that the cooking process is important as it can increase both familiarity, by involving processes that the person may be familiar with (e.g. baking), and sensory aspects of the food (by incorporating other ingredients; Wilkinson et al., 2018).

#### **1.4.4 Educational information.**

There is a large area of literature that discusses the relative importance of educational information in reducing the disgust associated with entomophagy. Some authors argue that by using informational campaigns and increasing education, entomophagy acceptance can be increased. A method suggested to increase acceptance of general meat substitutes is to develop educational campaigns and food labels that highlight: health and nutritional benefits, environmental benefits and method of production and animal welfare benefits (Apostolidis & McLeay, 2016). Another study found that providing information about the benefits of entomophagy increases participants intention to consume them, which then predicted behaviour (Verneau et al., 2016). These authors therefore encourage the use of information to increase acceptance. In a recent study the two main factors that affected hedonic responses towards insect food were previous experience of tasting insect food and, importantly, previous *knowledge* about entomophagy (Caparros Megido et al., 2016), which emphasises the importance of increasing education on the topic.

However, there are others who argue that increasing acceptance of alternative meats, such as insects, on the basis of ethical or environmental educational information will not be successful (e.g. Hartmann & Siegrist, 2016). This is due to individuals not putting a

large emphasis on the environmental consequences of their food choices (Verbeke, 2015), and oro-sensory characteristics of the food being more important than rational arguments (Hoek et al., 2011). Based on a cultural comparison of willingness to eat insects in the processed and unprocessed form, Hartmann et al., (2015) concluded that educational information based on the nutritional benefits of entomophagy will likely fail among some consumer groups. This is supported by a qualitative study which concluded that cognitive arguments, based on health and environmental benefits, would be inadequate at increasing insect consumption (Shan et al., 2015). This uncertainty about the effectiveness of educational interventions to increase entomophagy acceptance, suggests it is an intervention method that requires further investigation.

### **1.5 Moderating personality traits in food disgust research**

Certain personality traits could have moderating effects on outcomes in studies which induce negative emotions, such as disgust. The trait disgust sensitivity is the sensitivity to disgust from the various domains of disgust described by Haidt, McCauley, & Rozin (1994) – food, sex, hygiene, animals, body envelope violations and body products. It could be an important trait to measure in the present context because disgust has a negative effect on acceptance of meat substitutes (Siegrist and Hartmann, 2019). Furthermore, those who are sensitive to food disgust react with aversion to food cues that indicate an animal origin (Hartmann and Siegrist, 2018), so studies that include animal-based food products may benefit from the inclusion of a measure of disgust sensitivity.

The trait of food neophobia may also be important in food disgust research. Food neophobia is an aversion towards foods one has not encountered before and an

unwillingness to leave the food comfort zone (Meiselman, King, & Gillette, 2010). In many studies food neophobia is found to be the strongest predictor of willingness to consume insects (e.g. Hartmann et al., 2015; Hartmann & Siegrist, 2016; La Barbera et al., 2018; Schlup & Brunner, 2018; Verbeke, 2015) and underpins attitudes towards entomophagy (Wilkinson et al., 2018). Those who are lower in food neophobia have increased intention to eat insects (Sogari, Menozzi and Mora, 2018).

Sensation seeking is a trait that represents the tendency to partake in risky behaviour as a result of lacking stimulation from more neutral behaviours (Zuckerman, 2007). It was one of the best predictors of insect acceptance in an online study assessing attitudes towards food with American and Indian respondents (Ruby et al., 2015). It is therefore important to assess sensation seeking in research on novel foods as it could have a large effect on disgust responses to eating insect containing food. Also, decreased sensation seeking has been associated with increased disgust sensitivity (Christman, 2014; Dvorak, Simons, & Wray, 2011; Haidt et al., 1994).

Studies involving the ingestion of food and the induction of a stress eliciting state, such as threat, may benefit from the inclusion of a measure of emotional eating. Restrained and emotional eaters overeat when they feel stressed (Heatherton, Herman, & Polivy, 1991; Herman, Polivy, Lank, & Heatherton, 1987; Wallis & Hetherington, 2004). In studies that include the induction of threat it may be important to have a measure of participants' emotional eating as this trait could influence the amount of food they consume post emotional manipulation.

## 1.6 Gaps in the literature

Of all the research investigating ways to increase entomophagy acceptance none include food intake as a dependent variable/measure of acceptance, despite food intake being a clear, generally unconfounded and therefore important measure of acceptance. Some studies include the ingestion of insect containing food in their design but this has been to see how tasting will effect attitudes (Lensvelt & Steenbekkers, 2014; Looy & Wood, 2006; Sogari, 2015; Tan, Verbaan, et al., 2017), hedonic judgements (Caparros Megido et al., 2016; Pambo, Okello, Mbeche, Kinyuru, & Alemu, 2018; Tan, Tibboel, et al., 2017; Tan, Verbaan, et al., 2017), or willingness to eat in the future (Hartmann & Siegrist, 2016; La Barbera et al., 2018; Sogari et al., 2018; Tan, Tibboel, et al., 2017; Tan, Verbaan, et al., 2017; Verneau et al., 2016). However, none include a quantitative measure of food intake in the analysis model as a dependent variable. Including tasting in experimental designs is important. In a recent study where participants ate burgers containing a novel food ingredient, there were more negative *expectations* about the taste of the food than negative ratings of the *actual* taste (Tan, Tibboel, et al., 2017), which shows how expected judgements can be flawed in this context. Similarly, it has been found that sensory expectations differ from sensory judgements based on tasting (Pambo et al., 2018; Schouteten et al., 2016). While tasting alone is important, quantitatively measuring the food intake is more vital for this kind of research as it can be used as a measure of disgust response, with the assumption that if participants are feeling disgusted they will consume less food as the food will be rejected on the grounds of disgust.

Along with lacking quantitative measures of food intake, studies in this area have not measured the disgust response directly. Decreasing disgust is the counterpart of increasing

acceptance, though no study has investigated this. It is also important to use implicit measures (e.g. tactile sensitivity) of the disgust response towards the prospect of insect food ingestion, yet most previous research has not done this. This is particularly important in emotion research as individuals tend to be poor at self-reporting emotion (Schouteten et al., 2016). Previous studies have explicitly asked participants to report their emotions in response to an experimental manipulation (e.g. La Barbera et al., 2018; Pambo et al., 2018; Schouteten et al., 2016; Verneau et al., 2016). This method allows the demand characteristics of the study to influence the participants response and the measure's validity. In summary, disgust response should be measured in this area of research and it should be done so in an implicit way.

There is also a lack of studies developing methods to induce emotions in an ecologically valid way. This may be due to the ethical complications associated with the induction of negative emotions which has resulted in a lack of ecologically valid methods to induce negative emotions. It is also technically difficult to ensure that the target emotion alone has been induced – hence the use of emotion control conditions, such as the ‘threat’ condition used by Hunt et al., (2017). Ecologically valid ways to induce emotion, that are ethically sound, need to be developed.

Finally, of the studies investigating the moderating effects of certain personality traits on willingness to consume insect containing food or attitudes, only one (Sogari et al., 2018) measured food intake. However, this was done in a binary way in that the only recorded result was if participants tasted the insect food or not – a measure of the *amount* consumed was not reported. Again, investigations into the moderating effects of these traits on actual food intake, rather than explicit acceptance measures alone, is needed.

## 1.7 Project aims

This project aimed to test the effectiveness of educational interventions at reducing the disgust response towards food participants were told contained mealworm flour. To overcome short comings of the current literature in this area, the disgust response was measured using the *implicit* measure of tactile sensitivity, an exploratory measure of latency to eat (LtE) and was also signalled from the amount of food, believed to contain mealworms, that was consumed. Where disgust was induced due to the prospect of imminent consumption of mealworm-containing food, threat was also induced to control for general negative arousal. A second aim was to develop an appropriate method of inducing threat that was as ecologically valid as the inducer of disgust (food presented to the participant in the testing session).

## **2. Experiment One: Development of Emotion Induction Methods**

### **2.1 Introduction**

Many psychological studies induce a variety of emotions in order to investigate their effect on certain cognitive or behavioural mechanisms. When developing a method to induce a specific emotion it is vital that the method induces the desired emotion and no other, related, emotions and induces the target emotion to the severity required. Inducing negative emotions such as fear (general form of threat) and disgust can be limited due to ethical constraints (Valstar & Pantic, 2010), meaning robust techniques to induce these emotions are difficult to develop.

Disgust has been induced in a number of ways in previous studies. Short videoclips displaying surgery on humans and images showing the effect of certain diseases on humans have been shown to participants when investigating natural and spontaneous facial expressions of emotion (Valstar & Pantic, 2010). Based on the relatively objective measure of muscle activation to determine facial expression, the authors concluded that disgust had been induced. Another study induced disgust by giving participants a bitter tasting drink in order to assess the effect on perceptions of moral dilemmas (Eskine, Kacirik, & Prinz, 2011). This induction method was deemed effective as those who tasted the bitter drink experienced more feelings of moral disgust, showing that the induced disgust was strong enough to affect moral judgements. In one study both disgust and fear were induced using pictures and video clips accumulated from television news programmes. The pictures and video clips were compiled, with audio, into short videos showing news stories designed to induce the target emotions. The images had been selected on the basis of factor analysis



results which highlighted the pictures that best represented the target emotions (Newhagen, 1998). Images depicting fear and disgust were more memorable than neutral images which indicated that the target emotions had been experienced by the participants.

An arguably less successful method of induction was investigated in another study. Stimuli that spanned various modalities were used by asking participants to read mood-relevant vignettes and listen to mood-relevant music simultaneously. This was with the intention of inducing disgust, anxiety and happiness. To induce disgust the vignette described an unclean toilet while the participant listened to disgust inducing sound effects, such as the sound of vomiting. Anxiety was induced by Halloween related music playing while participants read about an ominous lake. These emotional inductions were supplemented by mood-relevant pictures (Davey, Bickerstaffe, & MacDonald, 2006). Results showed that those in the disgust or anxiety conditions reported more threat spellings of threat/neutral homophones compared to those in the happiness condition. This suggests that these emotion induction techniques led to more general negative arousal, or perhaps the target emotions were induced but the measurement technique (homophone categorisation) was not specific enough to detect this.

The feeling of threat, which leads to emotions such as fear and anxiety, has been induced to assess its effect on tactile perception. General threat and physical threat were both induced using pictures. Physical threat pictures depicted injury to the hand (Van Damme, Gallace, Spence, Crombez, & Moseley, 2009). Results showed that tactile *attention* (not sensitivity as it was a tactile temporal order task, not a sensitivity task) was heightened on the hand which had the picture placed in front of it. This effect was specific to physical threat and not general threat. A more recent study investigated the effect of fear on tactile

sensitivity (measured using a two-point discrimination task on the fingertip), while using anger in an emotional control condition. Fear and anger were induced using first, an emotional memory task and second, emotion relevant pictures (Kelley & Schmeichel, 2014). Both methods of emotion induction were deemed effective at inducing the target emotions as shown by differing tactile sensitivity measures compared to baseline after both emotional manipulations (tactile sensitivity increased in the anger condition and decreased in the fear condition).

When investigating one negative emotion it is useful to induce another type of negative arousal in the study design in order to control for the effect of general negative arousal on the dependent variables of the study. If the pattern of results that emerges from both conditions is different then it can be concluded that the pattern of results in the experimental condition was due to the target emotion itself and not negative arousal more generally. This approach was taken by both Kelley & Schmeichel (2014) and Hunt et al., (2017). When investigating the effect of disgust on tactile sensitivity Hunt et al., (2017) included a threat condition where participants viewed video clips of the Baltimore riots – these were chosen as they were threatening but not morally, or traditionally, disgusting. To induce disgust in this study, participants viewed videos of maggots. Indeed, different patterns of results emerged in the threat and disgust conditions – tactile sensitivity increased in the disgust condition but remained equivalent to the control in the threat condition. This implies that changes in tactile sensitivity were due to disgust alone, not general negative arousal.

A study in the NBU (Nutrition and Behaviour Unit) at the University of Bristol investigated the effect of insect containing food on tactile sensitivity. It was hypothesised,

and found, that anticipation of eating falafel, that participants were told contains mealworm flour (when in fact it did not), led to an increase in tactile sensitivity (Macmillan, 2017) – a finding that is in-keeping with those of Hunt et al (2017).

The present study was designed to investigate if two methods, one designed to induce disgust and one to induce threat, a) induce the intended affective state (either disgust or threat) alone; and b) induce the two states to an equivalent intensity. Disgust was intended to be induced by asking participants to eat supposed mealworm-containing falafels – a method that has been shown to be effective in the previously described NBU study. While methods such as video clips and pictures have been effective in inducing threat in previous research (e.g. Hunt et al., 2017; Newhagen, 1998; Van Damme et al., 2009), they were not suitable for the present study's design. This was because the inducer of disgust in the present study was an event that would take place in the present to the participant – it is not an imagined or viewed scenario, it is believed to be real. It was therefore the intention that the inducer of threat should be equally present, 'real' and should happen during the testing session. This is of course ethically complicated and inducing extreme threat in participants was not the intention. Threat can be defined as "an intention to inflict pain, injury, damage" (<https://en.oxforddictionaries.com/definition/threat>). It was therefore important that the method to induce threat included an element of (mild) pain.

The proposed method of threat induction was to tell participants that during the testing session they would need to have blood sample taken which would be obtained by a finger prick. This was chosen as it could be easily justified to participants (saying the study was designed to investigate blood glucose levels) and was a feasible and not too extreme method.

In order to assess the usefulness of this method as a way to induce threat, three short questionnaires were developed – one for each target state (disgust and threat) and a control. It was hypothesised that words associated with disgust would characterise responses in the Disgust condition, and words associated with threat (e.g. anxiety and fear) would characterise responses in the in the Threat condition. In the Control condition no clearly defined, or intense, emotions would be induced. The severity of the emotions induced in the Threat and Disgust conditions would not be significantly different but they would both be significantly higher than the Control condition.

## **2.2 Version One**

### **2.2.1 Method.**

#### ***2.2.1.1 Participants.***

Seven adult participants completed the first version of this study. Initially this study was only intended to be a pilot study and a justification of methods so widespread participant recruitment was not undertaken – hence the small number of participants. The sample was obtained through opportunity sampling only. No demographic or personal data was collected so all participants were anonymous. The study was granted ethical approval by the University of Bristol Ethics Committee (approval Code: 12031863762).

#### ***2.2.1.2 Design and Procedure.***

There were three questionnaires and conditions – Control, Disgust and Threat. There was a within-subjects design. All participants completed all three questionnaires (shown in Appendix A) in paper form in a random order, in one sitting, in the presence of the experimenter.

#### ***2.2.1.3 Questionnaires.***

Each questionnaire began by describing a different hypothetical situation which participants were asked to imagine themselves in. The Control questionnaire described being asked, as part of a Psychology experiment, to eat normal chickpea falafels. The Disgust questionnaire described being asked to eat falafels that contain mealworm flour. The Threat questionnaire described being asked to have a finger prick to obtain a blood sample. A picture was included to illustrate the described scenario. Following this there

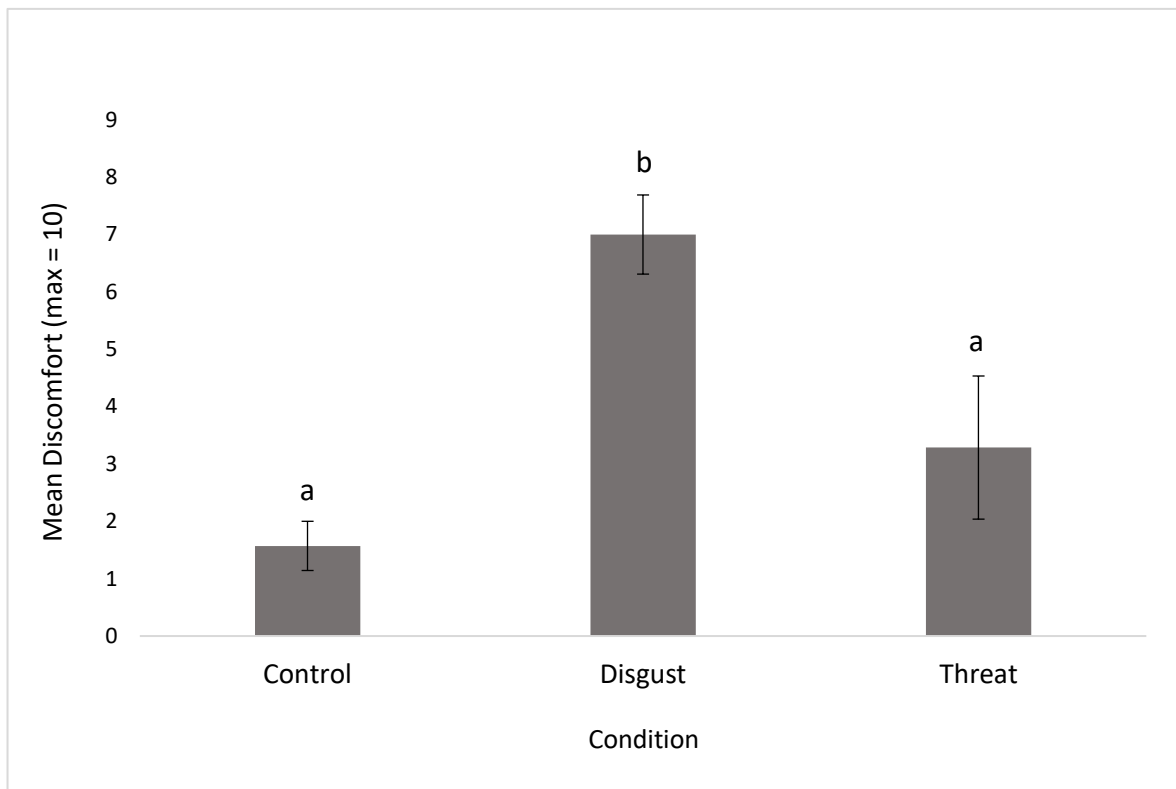
were five questions. Three were short answer questions about the emotions participants may experience in the given scenario. One was a multiple-choice question assessing the participants willingness to participate in a study of this nature. The final one was a quantitative measure included to assess the extent of 'discomfort' feelings that the participants might experience when in the given scenario. This was included in order to have a quantitative comparison of the intensity of each emotion and was in the form of a 10-point Likert-type scale anchored 'No discomfort at all' and 'Extremely uncomfortable'.

#### **2.2.1.4 Analysis.**

The quantitative scale data was analysed using an ANOVA to compare mean ratings of discomfort in each condition. The data from the written responses was not analysed, though were informative.

#### **2.2.2 Results.**

A one-way repeated measures ANOVA was conducted to compare the effect of condition on the ratings of discomfort. The mean scores for discomfort were statistically significantly different between conditions ( $F(2, 12) = 10.63, p = .02$ ). Post hoc tests revealed that mean ratings of discomfort in the Control condition ( $M = 1.6, SD = 1.1$ ) were significantly lower than mean ratings in the Disgust condition ( $M = 7.0, SD = 1.8; p < .01$ ), but not significantly different from the Threat condition ( $M = 3.3, SD = 3.3; p = .23$ ). Mean values and standard error are shown in Figure 1.



**Figure 1.** Mean discomfort scores in each condition with standard error bars. Means not sharing a superscript letter in common (a,b) differ significantly ( $p < .01$ ).

### 2.2.3 Interim discussion.

As expected, discomfort in the Disgust condition was higher than in the Control condition, however discomfort scores were not significantly higher in the Threat condition compared to the Control. This suggests that using the finger prick method to induce threat does not induce a level of discomfort that is comparable to that in the Disgust condition and therefore may not be a suitable method when controlling for negative arousal. Explanations given by participants led to the attribution of this lack of threat to the familiarity of a finger prick. One participant said,

“I would feel like this [ok] because of previous experiences.”

Another participant stated,

“I also know that actually the pain isn’t that bad.”

Based on the quantitative measure, and these explanations, it seems these participants did not feel sufficiently threatened and this was due to their existing knowledge of what a finger prick feels like.



## **2.3. Version Two**

### **2.3.1 Interim introduction.**

This preliminary finding led to the development of a method to induce threat that would not be familiar to participants - a tongue biopsy method was therefore proposed. This method was described to participants as being a “small, harmless biopsy (incision to obtain sample) on your tongue”. This method was used as the process is similar to a finger prick (a small cut) but on an area of the body that is not usually intentionally harmed in this way, thus making it less familiar to participants. A questionnaire identical to the previous three was added to the study which asked participants to imagine themselves being asked to have a tongue biopsy as part of a study. The revised hypotheses were:

- 1) The mean level of discomfort in the Threat TB (tongue biopsy) condition would not be significantly different to the mean level of discomfort in the Disgust condition. The mean level of discomfort in the Threat FP (finger prick) condition would be significantly lower than both the Threat TB and Disgust conditions.
- 2) The mean level of discomfort for the Control condition would be lower than that for the Threat TB and Disgust conditions and would not be significantly different to the mean level of discomfort in the Threat FP condition.
- 3) The prospect of eating mealworm-containing falafels would induce disgust (and synonymous emotions), the prospect of a tongue biopsy would induce threat (and synonymous emotions) and the prospect of a finger prick would not induce threat due to familiarity with the procedure.

### **2.3.2 Method.**

#### **2.3.2.1 Participants.**

58 participants took part in this study. No demographic data was collected from participants though they were all over 16. Opportunity sampling was used to obtain participants. Some were recruited at a Neuroscience Festival, some from schools (both teachers and pupils) and some were university students. This study was granted ethical approval from the University of Bristol Ethics Committee.

#### **2.3.2.2 Design.**

As in version one, there was within-subjects design. There were four conditions, and questionnaires, which every participant was asked to complete in the same way as version one. All 58 participants did the Disgust and Threat FP questionnaires (though some did not complete the quantitative scale), but one participant did not complete the booklet of questionnaires so only 57 participants completed the Control and Threat TB questionnaires.

#### **2.3.2.3 Analysis.**

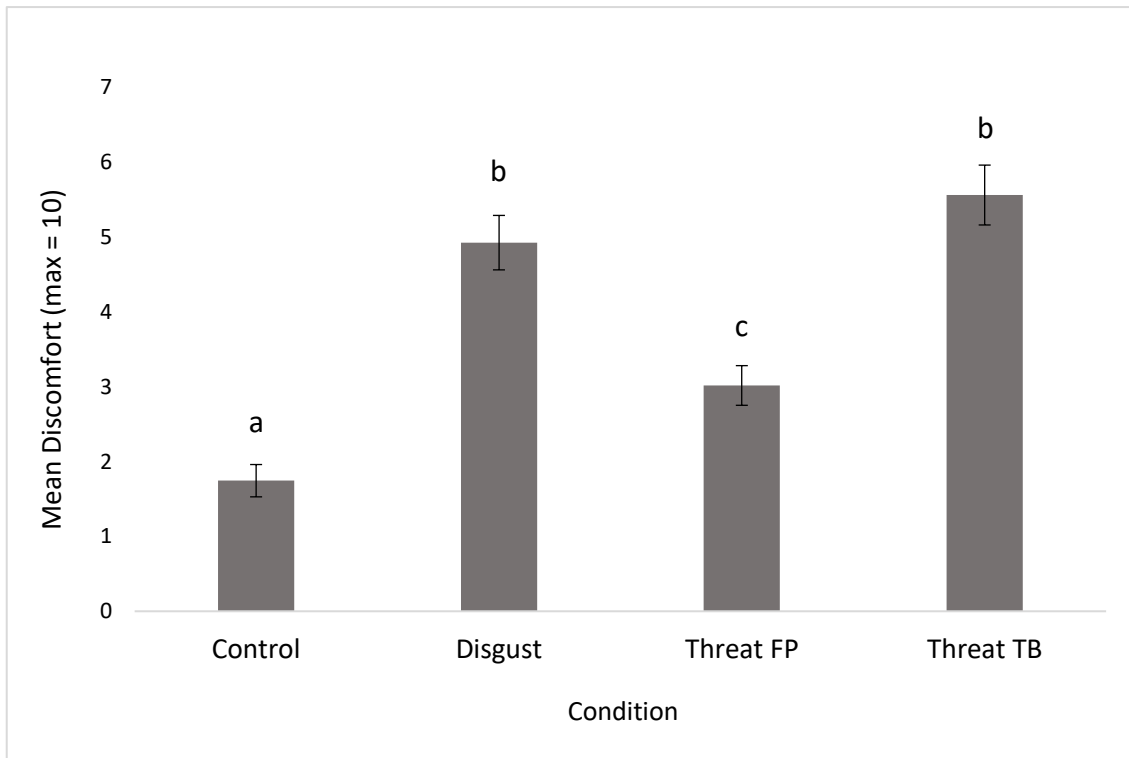
Mean ratings of discomfort in each condition were compared using ANOVA analysis. The qualitative data from version two was analysed using the Thematic Analysis approach described in Braun & Clarke (2006). There were many stages to analysis starting with data familiarisation by reading the questionnaire responses thoroughly. The thematic framework was identified both deductively (by investigating the emotions that were outlined beforehand) and inductively (through careful acknowledgement of concepts that emerged from the data upon analysis, but had not been outlined previously). Data was then coded to highlight recurring concepts or emotions. The list of codes was revised and edited. Following

this, the codes were grouped to reflect overarching themes in the data. The themes, and links between them, were carefully considered and revised multiple times with reference to the data to ensure the themes represented the data accurately. Analysis was carried out using NVivo software.

### **2.3.3 Results.**

#### **2.3.3.1 Quantitative scale data.**

Four participants were excluded from this analysis as they did not complete the quantitative scale questions in every condition – 54 were included. A one-way repeated measures ANOVA was conducted to compare the effect of condition on the ratings of discomfort. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated ( $\chi^2(2) = 24.57, p < .05$ ). With Huynh-Feldt correction, the mean scores for discomfort were statistically significantly different between conditions ( $F(2.44, 131.88) = 33.47, p < .01$ ). Post hoc tests revealed that mean ratings of discomfort in the Control condition ( $M = 1.8, SD = 1.6$ ) were significantly lower than mean ratings in all other conditions ( $p < .01$ ). Ratings of discomfort in the Disgust ( $M = 4.9, SD = 2.7$ ) and Threat TB ( $M = 5.6, SD = 2.0$ ) conditions were significantly higher than ratings of discomfort in the Threat FP condition ( $M = 3.0, SD = 2.1; p < .01$ ). Ratings of discomfort in the Disgust and Threat TB conditions were not significantly different ( $p = .23$ ). Means and standard error are shown in Figure 2.

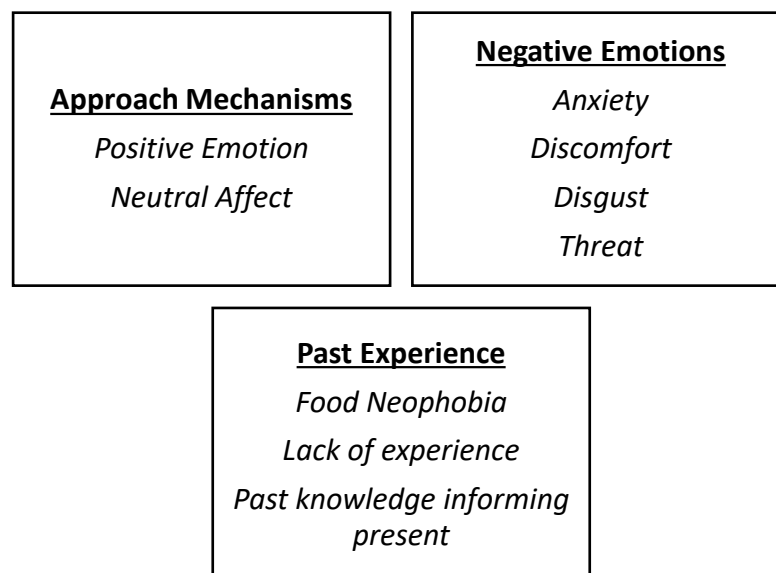


**Figure 2.** Mean discomfort scores in each condition with standard error bars. Means that do not share a superscript letter (a,b,c) differ significantly ( $p < .01$ ).

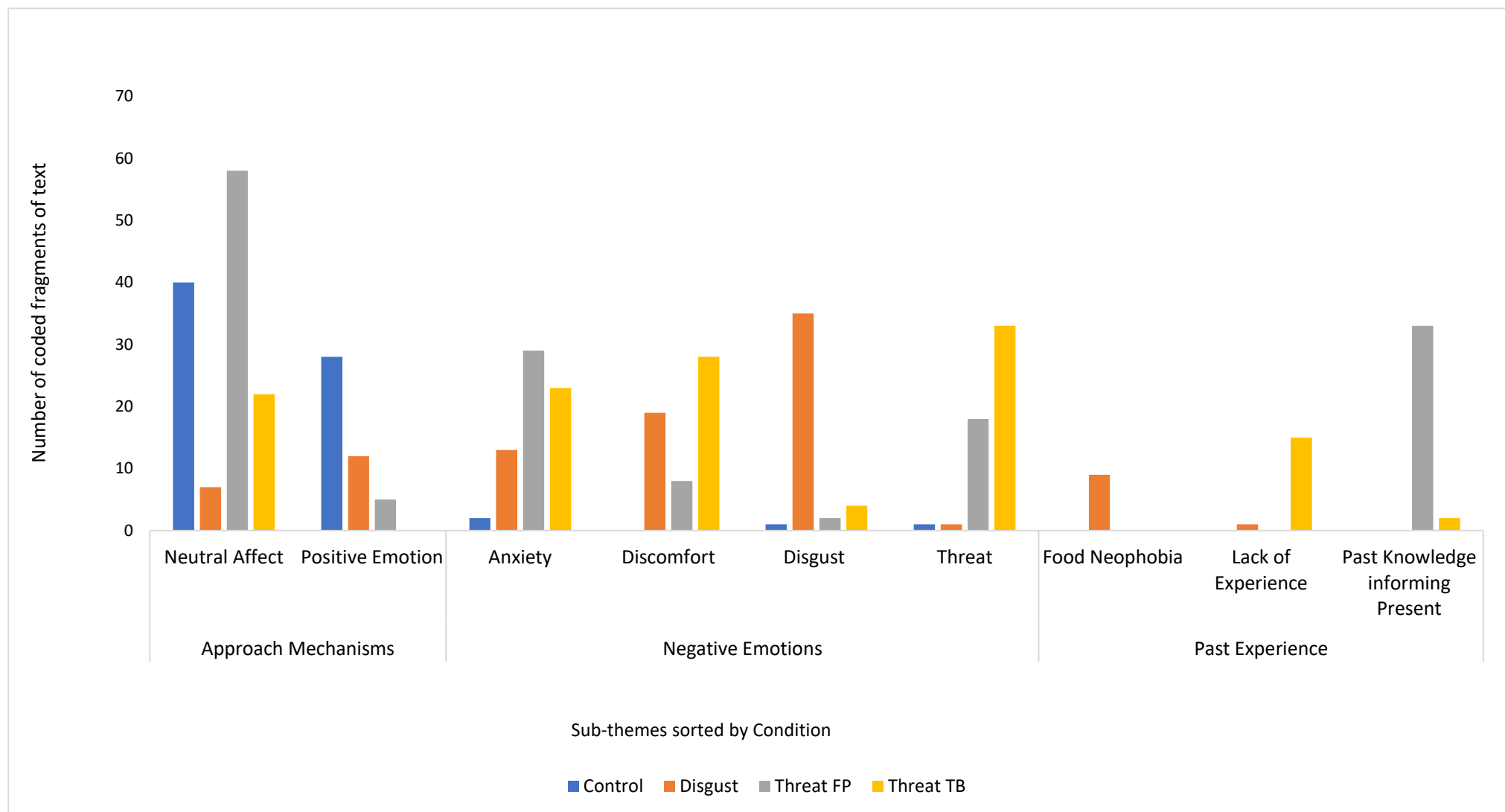
#### **2.3.3.2 Qualitative data.**

The Thematic Analysis led to emergence of three main themes: Approach Mechanisms, Negative Emotions and Past Experience. They were all comprised of sub-themes which are shown in Figure 3. The theme Approach Mechanisms represents data which suggested the participant was willing, and even positive about, the scenario described. The theme Negative Emotions represents the array of negative emotions and states that were expressed in participant responses – this theme is important because of its clear association with the hypotheses of this study. The theme Past Experience represents participant response that focused on past experiences, or lack thereof, as a justification for their feelings towards the described scenario. Every theme did not emerge in all four

conditions, though some themes emerged in multiple conditions. Figure 4 shows the number of coded responses for each sub-theme, sorted by theme, in each condition. The Approach Mechanism sub-theme *neutral affect* was the sub-theme that emerged the greatest number of times in the data. Each condition will be discussed by outlining the themes that emerged from it.



**Figure 3.** The three themes that emerged from the data and the sub-themes within each one.



**Figure 4.** Table showing the number of coded responses in each condition, organised by theme and sub-theme.

#### 2.3.3.2.1 Control.

The majority of participants responses in the Control condition could be characterised by Approach Mechanisms – as seen in Figure 5. Overwhelmingly, participants had *neutral affect* towards the Control scenario. They did not have a strong emotional response or change in emotions as a result of the scenario. Participants claimed to feel,

“Indifferent”

“Fine”

“Completely normal”

with some stating,

“I would feel the same as I did before”

“Wouldn’t have an issue with it”

“I would feel neutral”

The second largest subtheme to emerge from the Control condition was *positive emotion*. Many participants claimed to be,

“Happy”

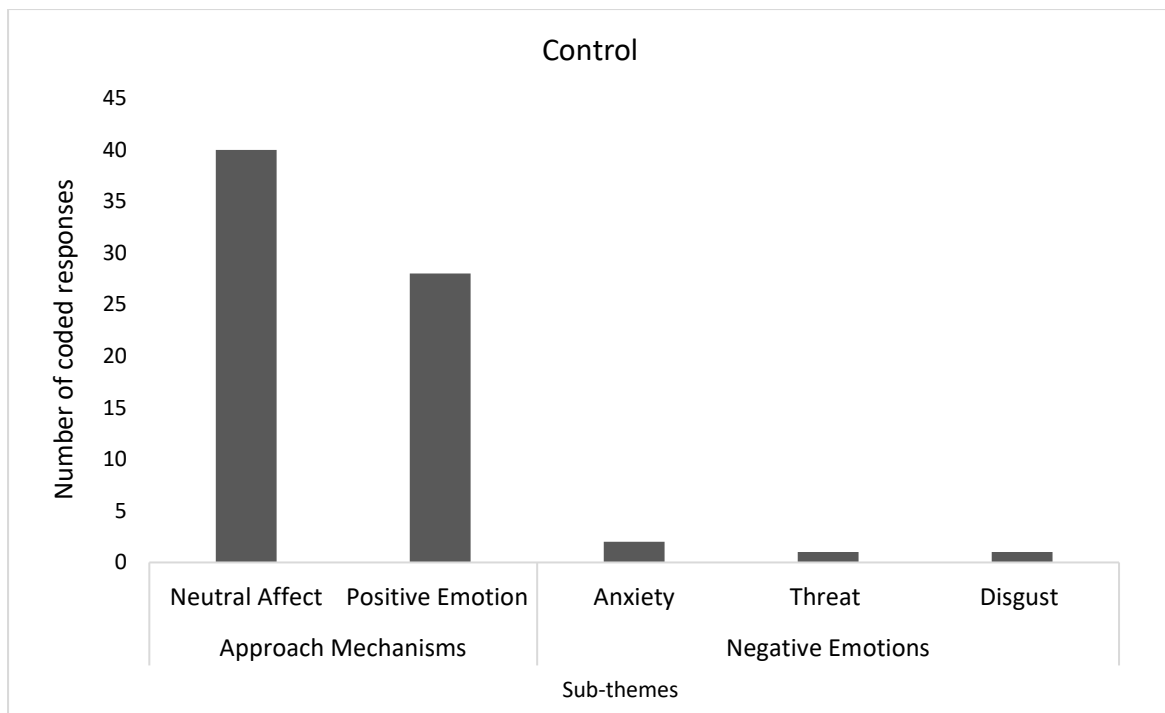
“Excited”

“Pleased”

“Comfortable”

with one explaining,

“Happy because it would be a pleasant surprise”



**Figure 5.** Bar chart showing the number of coded responses for each sub-theme, sorted by theme, in the Control condition.

Some negative emotions were expressed (*anxiety*, *threat* and *disgust*) but only among those who claimed to dislike chickpeas. Negative Emotions is therefore not a key theme that emerges from this condition.

#### 2.3.3.2.2 *Disgust.*

The theme that best represented the data from the Disgust condition was Negative Emotions, as shown in Figure 6. The negative emotion that most frequently emerged was *disgust*. Many participants claimed to feel,

“Disgusted”

“Uneasy”



“Queasy”

“Sickened”

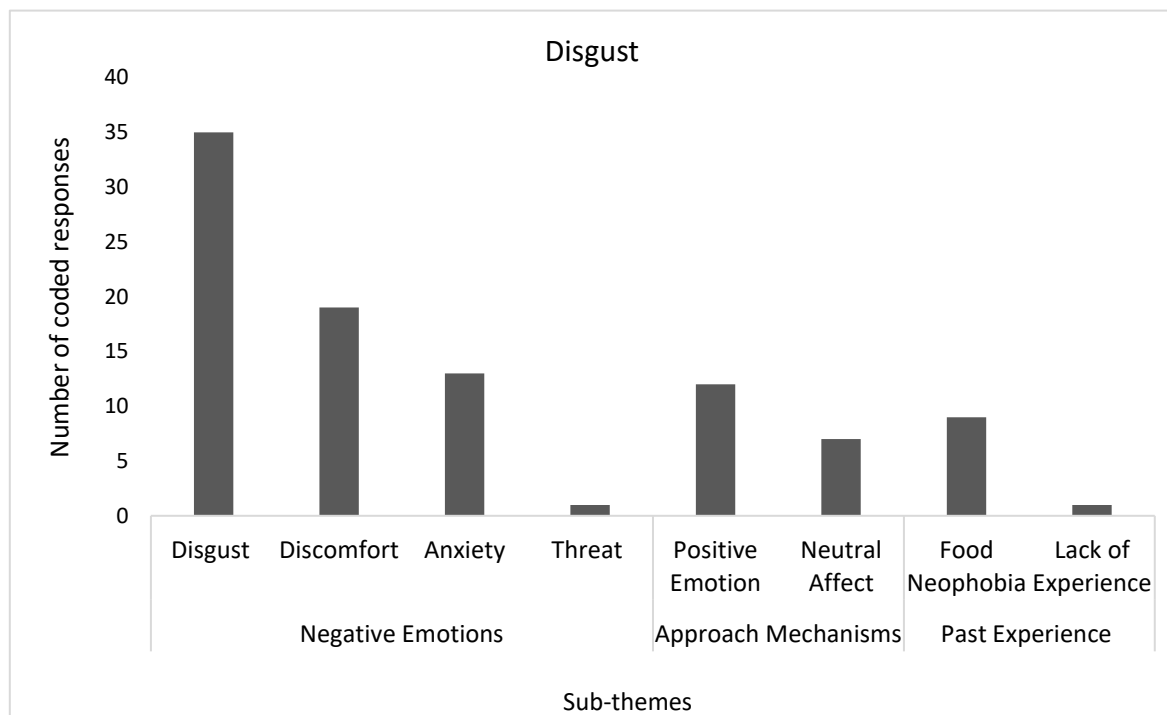
“Nauseous”

- all words synonymous with disgust. Participants explained these emotions:

“I imagine them living in dirty environments, which leads to the feeling of slight disgust”

“Strangeness and revulsion associated with the ingredients”

“Because the idea of eating something that is associated with worms or maggots seems disgusting”



**Figure 6.** Bar chart showing the number of coded responses for each sub-theme, sorted by theme, in the Disgust condition.

*Discomfort* was another negative emotion that emerged in the Disgust condition as many participants claimed they would feel uncomfortable when asked to eat mealworm-containing falafel,

“I would feel very uncomfortable at the thought of having to eat mealworms”

“Uncomfortable as eating insects is not part of my dietary requirements”

“I would be uncomfortable and disgusted by the prospect of eating insects”

The sub-theme of *anxiety* also emerged in the Disgust condition as participants used the word ‘anxiety’, and synonymous words, to describe their emotions. For example:

“Nervous”

“Worried”

“Anxious”

Participants stated they would be,

“A little anxious and not looking forward to it”

“I would be nervous”

“I would feel anxious because I wouldn’t want to eat the falafels”

The theme of Approach Mechanisms emerged in the Disgust condition as some participants claimed to feel *neutral affect* and experience the *positive emotion* of “excitement”. On the whole this was associated with it being a new experience. For example:

“Almost excited to see what they tasted like”

“Happy to be trying something new – excited even”

“There’s a degree of excitement in trying a new food for the first time”

“Excited to try a new and innovative food item”

This is in contrast to another important sub-theme that emerged – *food neophobia*. Many participants attributed any negative emotions to having not eaten mealworm flour before. For example:

“I would feel this way [queasy, apprehensive, worried] mainly due to it being an unknown food”

“It would make me feel concerned as I have never tried something like this before”

“Apprehensive as I haven’t eaten mealworm flour before”

“This would make me feel curious and a bit uncomfortable as I have never eaten falafels I have also never eaten insects.”

“I would feel like this [curious, a bit uncomfortable] as I have never eaten insects”

The sub-themes of *threat* and *lack of experience* only emerged once each in the Disgust condition (Figure 6), therefore they were not key sub-themes in this condition.

#### 2.3.3.2.3 Threat Finger Prick.

The most notable sub-themes to emerge in the Threat FP condition were *neutral affect*, *past knowledge informing present* and *anxiety*. *Neutral affect* was coded the greatest number of times in this condition compared to other conditions, as well as *past knowledge*

*informing present* and *anxiety* (Figure 4). *Neutral affect* was the sub-theme that emerged most in this condition (Figure 7). Participants stated:

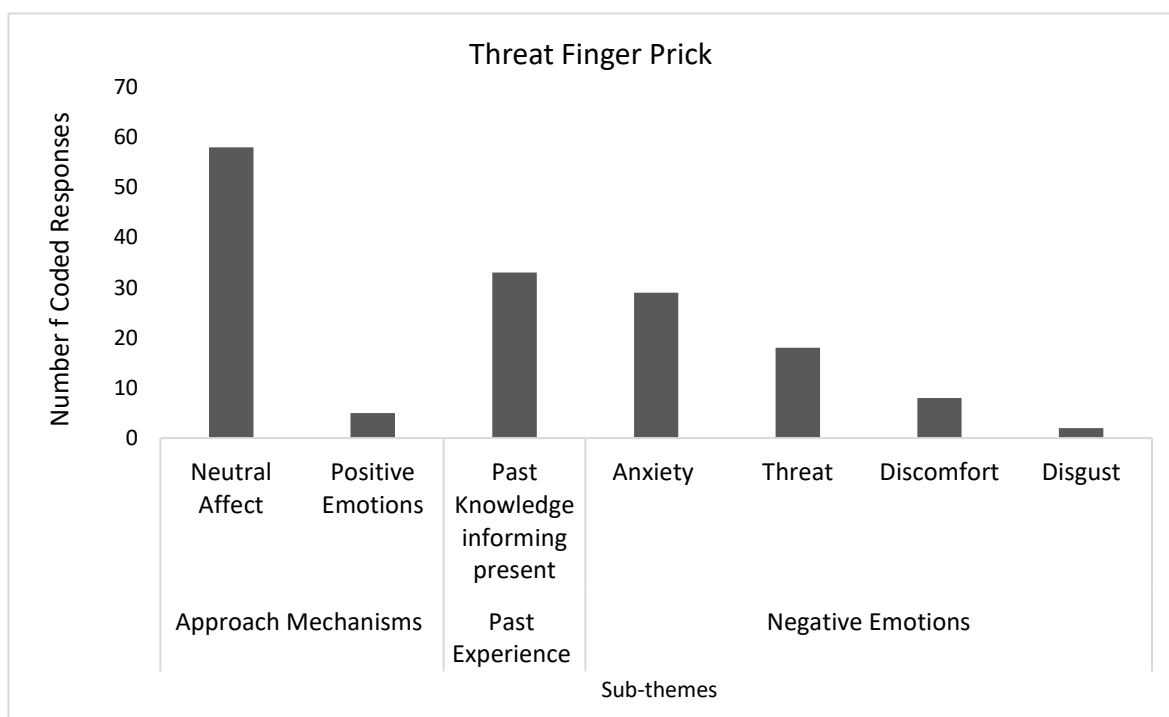
“This wouldn’t make me feel very much at all”

“A finger prick wouldn’t worry me”

“I would feel very neutral about it”

“I have no problem getting my finger pricked”

“I would feel fine and no different to normal”



**Figure 7.** Bar chart showing the number of coded responses for each sub-theme, sorted by theme, in the Threat FP condition.

It is likely that this lack of emotion is due to participants being familiar with the feeling so there is not a sense of anticipation. This concept is represented by the sub-theme *past knowledge informing present* which was the second largest sub-theme to emerge in this condition. Participants explained:

“I would feel fine as I know it is not actually that painful based on past experience with injections”

“I have had this done before so am aware that it causes no pain or damage”

“Taking a blood sample is a simple routine procedure that many would be accustomed to”

“Have had it done before, not painful and is a quick process”

“I have had to do this before and understand that it is not very painful at all”

“Have had this done lots of times before so would know exactly what to expect”

“It’s something most people have experienced before without having any trouble”

The theme Negative Emotions also emerged in the Threat FP condition. This was largely in the form of the sub-themes *anxiety* and *threat*. The language used by participants was reminiscent of mild emotions. For example:

“Slightly uneasy and anxious”

“Very slightly on edge, but really not worried at all”

“A degree of anxiety while waiting, although not substantial”

“A little scared/nervous”

Due to the use of words such as “slightly” and “a little” these emotions seem very mild.

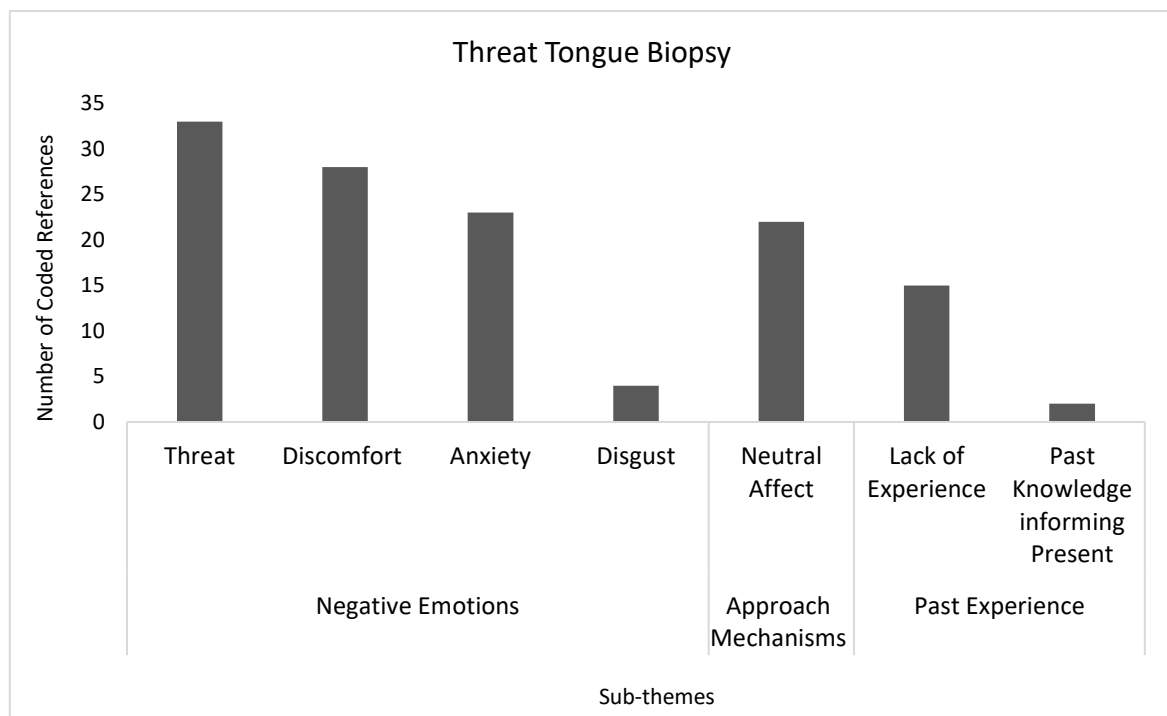
#### 2.3.3.2.4 Threat Tongue Biopsy.

The sub-theme that emerged most from the Threat TB condition was *threat* – shown in Figure 8. As threat is characterised by, and defined as, “an intention to inflict pain, injury, damage”, the fear/anticipation of pain may be a key aspect of feeling threatened which separates it from other affective states. This was a concept that emerged from the data.

Participants stated:

“The biopsy seems potentially painful”

“Anticipation of the initial pain from the incision”



**Figure 8.** Bar chart showing the number of coded responses for each sub-theme, sorted by theme, in the Threat TB condition

The emphasis on pain was a large part of all the key sub-themes that represented this condition – other negative emotions were frequently linked back to a root in fear of pain. *Anxiety* and *discomfort*, for example emerged as sub-themes in this condition and were often explained as being due to fear of pain. Emotions stated by participants were:

“Nervous”

“Slightly worried”

“Probably quite nervous. Slightly worried”

“Very unhappy and uncomfortable and uneasy”

In all of these cases these emotions were attributed to pain. For example:

“fear of pain”

“the prospect of an unknown amount of pain”

“A cut tongue would be painful”

“feel uncomfortable because of the sensitivity of the tongue”

The theme Past Experience also emerged in this condition. Often the fear of pain (*threat*) that was experienced by participants was attributed to their *lack of experience* with the procedure. Participants stated:

“I have never experienced anything similar and suspect it would be very painful and unpleasant”

“Because it’s on the tongue and I’ve never experienced it before is why I would feel a little weird”

“Because I would feel pain and have no idea what it would feel like”

“I have also never had this procedure done before so would be more anxious about it  
because I don’t know what it’s like”

This view was widespread in this condition.

Other participants had neutral feelings towards the tongue biopsy procedure, so the sub-theme of *neutral affect* was also important in this condition. Participants stated:

“Small procedure that will not hurt so this would not bother me”

“Harmless so will not affect me in any way”

“It’s safe and easy and it’s no real trouble for me”

Overall, neutral feelings were outweighed by negative emotions which likely explains the quantitative measure of discomfort being highest in this condition, despite the emergence of *neutral affect*.



## 2.4. Discussion

This study aimed to determine if suggested methods to induce threat and disgust were viable. Following initial analysis on the first version of the questionnaires, another threat induction method was included in the set of questionnaires that would be less familiar – a tongue biopsy. The thematic approach taken in this study was insightful as thematic analysis uncovers patterns in the data (Joffe, 2012) while organising the data to describe it in detail (Braun & Clarke, 2006). The optimal thematic analysis approach is to combine deductive and inductive approaches (Joffe, 2012), as this analysis did.

The findings were mostly in-keeping with the revised hypotheses:

- 1) Those in the Disgust condition and Threat TB condition experienced equivalent levels of discomfort in response to the described scenario as shown by the quantitative scale data. This is in contrast to results from the Threat FP condition in which participants ratings of discomfort were significantly less than those in the Disgust and Threat TB conditions.
- 2) While those in the Disgust and Threat TB conditions experienced significantly higher levels discomfort than those in the Control condition as predicted, contrary to the second hypothesis those in the Threat FP condition experienced significantly more discomfort than those in the Control condition.
- 3) The results from the thematic analysis suggest that the emotion experienced in the Disgust condition was disgust while the state induced in the Threat TB condition was threat specifically. The sub-theme *past knowledge informing present* emerging from the Threat FP condition is in-keeping with the hypothesis that a lack of emotion in the Threat FP condition would be due to a familiarity with the procedure.

The sub-theme of *food neophobia* was apparent throughout the Disgust condition analysis as many participants attributed their feelings of disgust and discomfort to having never eaten mealworm-containing food before. Positive emotion also emerged from the Disgust condition but this was exclusively related to curiosity and excitement associated with trying a new food – likely from participants who did not have strong neophobic feelings. A similar response was exhibited in a study assessing attitudes towards entomophagy using interviews. A small number of the participants viewed entomophagy as novel and potentially enjoyable, while the majority viewed the practice as disgusting (Myers & Pettigre, 2018).

In the Threat TB condition the most expressed ‘negative emotion’ was *threat* followed closely by *discomfort*. The results from the Threat TB condition were in stark contrast to those in the Disgust condition as *disgust* emerged much more frequently in the Disgust condition and there was an absence of *threat*, while the exact converse emerged in the Threat TB condition. The feeling depicted being threat is likely as participants justified the feeling as being due to the ‘fear of pain’ which threat tends to be uniquely associated with. Participants also widely discussed their *lack of experience* with a tongue biopsy – the lack of familiarity may mostly explain the heightened threat compared to the Threat FP condition. Emotions in the Control condition were overwhelmingly neutral and positive.

Results from the version one and two analyses showed that using a finger prick method to induce threat did not induce the adequate amount of emotion as shown by the quantitative measure. Analysis from version one suggested that this was likely due to participants familiarity with the procedure leading to overall neutral feelings towards it. This

conclusion, and subsequent hypothesis, is supported by the qualitative analysis in version two, making this explanation highly likely.

These methods of emotion induction may be useful for future research interested in threat and disgust. Previous research has focused on emotion induction methods that are largely hypothetical/imagined (e.g. Davey, Bickerstaffe, & MacDonald, 2006; Newhagen, 1998; Valstar & Pantic, 2010; Van Damme et al., 2009). While this has been useful in the given studies, for those who are designing studies where an emotion is induced through a present event those methods are not suitable (e.g. Eskine, Kacirik, & Prinz, 2011). The methods developed in this study are therefore very useful ways to induce negative emotions that are not hypothetical, yet not too severe, as shown by mean discomfort reported in the quantitative scale data not being above six in any condition. It is worth noting that the tongue biopsy would not actually have to take place during a testing session, nor is it intended to in the present project – the anticipation of it, while measures are taken, may be sufficient and much more practical. When using this method, it would be important to emphasise to participants the cleanliness of the procedure and that a medical professional would administer it. This is in order to reduce any potential disgust associated with it, such as disease spread due to an incision, which would undermine the aim of inducing a negative affective state distinct from disgust.

This study was limited by not including demographic data from participants. While they varied in age and gender, it was not recorded. It may have been useful to see if there were patterns in emotions that emerged as a result of a certain demographic characteristics in order to better understand how to induce emotions. In addition, verification from a lab-

based study using the tongue biopsy method would be needed in order to more robustly assess its usefulness.

## **2.5. Conclusion**

Results of this experiment showed that disgust would be induced if participants were asked to eat mealworm-containing falafels and threat would be induced if participants were told they would need to have a tongue biopsy. The severity of discomfort elicited in these two conditions was equivalent and higher than that in the Control and Threat FP conditions. Emotions induced from being asked to have a finger prick are not representative of threat – this is likely due to past experiences with finger pricks leading to comfort in the present. Emotions remain affectively neutral or positive when participants are asked to eat normal chickpea falafel. The use of the tongue biopsy method to induce threat is therefore recommended.

### **3. Experiment Two: Investigating the effectiveness of Educational Interventions**

#### **3.1 Introduction**

Entomophagy, the practice of eating insects, occurs in many parts of the world (e.g. Asia, South America and many parts of Africa). As the demand for animal protein is expected to rise over the next 10 – 30 years (Pelletier & Tyedmers, 2010; van Huis & Oonincx, 2017), and the livestock sector is the third largest contributor to climate change (Steinfeld et al., 2006), a sustainable alternative protein needs to be incorporated into the Western diet. Insects may be a solution due to their environmental sustainability (Alexander et al., 2017; Oonincx & de Boer, 2012; Smetana et al., 2016; van Huis, 2015, 2016; van Huis & Oonincx, 2017; van Huis et al., 2013) and their nutritional superiority to some conventional meat (Belluco et al., 2013; DeFoliart, 1992; Kouřimská & Adámková, 2016; Nadeau et al., 2015; Sun-Waterhouse et al., 2016; van Huis et al., 2013).

Over 1900 species of insects are already regularly eaten by two billion people worldwide (van Huis et al., 2013). Despite this, and the benefits of entomophagy, the practice remains widely unacceptable in the West (Hartmann & Siegrist, 2016; van Huis et al., 2013). This lack of acceptance, and consumption, can be attributed to the emotion of disgust that is associated with the ingestion of insects, as disgust is a form of food rejection (Rozin & Fallon, 1987). This explanation is supported by studies which assessed attitudes towards entomophagy and found that disgust emerges as the most common response, and the largest barrier, to entomophagy (Cicatiello et al., 2016; Menozzi et al., 2017; Ruby et al., 2015). Disgust therefore needs to be reduced (Gmuer, Guth, Hartmann, & Siegrist, 2016; van Huis et al., 2013).

Many studies have investigated the negative attitudes towards insect consumption in the West to better understand how they can be overcome. This has led to contradictory conclusions about the effectiveness of educational information as a method to increase acceptance of entomophagy. Those in support of educational interventions have found that educational information can be used to increase positive attitudes towards entomophagy (Lensvelt & Steenbekkers, 2014), for example through the use of educational 'Bug Banquets' (Looy & Wood, 2006). In one study, participants who were given information about an insect containing burger liked it significantly more and perceived it as significantly more nutritious and of higher quality, compared to a previous condition where they were not given information (Schouteten et al., 2016). However, as the disgust response is a deep-rooted visceral response (Looy, Dunkel, & Wood, 2014) other authors argue that rational arguments, such as those based on sustainability and nutritional advantages, cannot overcome it (Hartmann et al., 2015; Hartmann & Siegrist, 2016; Hoek et al., 2011; Verbeke, 2015).

In recent years, the importance of the environmental and nutritional advantages of entomophagy has increased and these may be key drivers of reducing the emotion of disgust – not only increasing positive attitudes. Preliminary work from the NBU at the University of Bristol has found that a written text outlining the sustainability advantages of entomophagy decreases the disgust response (measured by tactile sensitivity) towards the prospect of eating falafels which are believed to contain mealworm flour (Macmillan, 2017). An online survey assessing attitudes towards food revealed that the most common perceived benefits of entomophagy among American and Indian respondents was the environmental sustainability and the nutritional advantages. These beliefs about the benefits of eating insects was one of the best predictors of acceptance (Ruby, Rozin and

Chan 2015). Menozzi et al (2017) measured intention to, and behaviour of, eating insects in the next month. The belief that insects have positive effects on health and the environment significantly predicted attitude towards entomophagy and intention to eat. Environmental benefits have been shown to be an important factor motivating consumption of insects (Sogari, 2015) especially among those with higher intelligence and, therefore presumed, environmental awareness (Cicatiello et al., 2016).

Of the studies outlined so far none include actual food intake as a primary measure. Despite studies which claim that intention and behaviour are affected equally by a certain intervention (e.g. Verneau et al., 2016), when investigating eating *behaviour* it is important to measure behaviour itself as attitudes are not synonymous with behaviour and, therefore, should not be used as a more easily measured substitute (Kraus, 1995). For example, despite health and environmental benefits of entomophagy being rated as highly important, participants rated the *relevance* of those arguments more highly than the *actual* influence of the arguments on their willingness to consume insects (Schlup & Brunner, 2018). The authors attribute this to a disconnect between intention and behaviour. This can be described as the Attitude-Behaviour Gap which posits that attitudes alone are often poor predictors of behaviour (Ajzen, 2001; Vermier & Verbeke, 2006). This highlights the importance of measuring behaviour rather than self-reported attitudes or willingness/intention to act.

In addition to measuring behaviour, it is also beneficial to use implicit methods when measuring emotion, such as tactile sensitivity (as used by Hunt et al., 2017), to potentially rule out demand characteristics as an explanation of an intervention's effects. Even food intake could be subject to demand characteristics. For example, 'the experimenter expects



me to eat this food because s/he has explained how eating insects is good for the planet’.

The present study utilised tactile sensitivity as an implicit measure of the disgust response, along with latency to eat (LtE). LtE was included as a largely exploratory measure as it has not previously been used in this way. Food intake was also used to measure the disgust response – as disgust feelings increase, intake would decrease as the food is rejected. This was to overcome the associated limitations of failing to measure actual behaviour.

Furthermore, as identifying ways to increase intake of more sustainable food is a key objective of this research, even an increase being due to demand characteristics (e.g. ‘I should do this’) rather than due directly to decreased disgust would be noteworthy and encouraging. In addition to the implicit measures of disgust, explicit self-report measures of liking and desire to eat (DtE) the food, and food disgust were included. The former two measures were included as they are measures of *distaste* which is a component of disgust (along with ideational factors) and therefore indirectly signify the emotion of disgust.

The present study aimed to test the effectiveness of educational information, specifically with a focus on the environmental and nutritional advantages of entomophagy, to reduce the experience of disgust when asked to eat supposed mealworm-containing falafels. None of the falafels used actually contained mealworm flour, but participants were led to believe they did. This was to maintain visual and oro-sensory consistency between the conditions in order to understand the effect of emotions in isolation from sensory confounds. The nutritional and environmental advantages were used because these factors appeared to be important across many studies. The educational information also described how the environments in which mealworms are reared for human consumption are hygienic. This was to reduce the widespread association of insects with vectors of disease (Lensvelt & Steenbekkers, 2014; Lorenz et al., 2014; Ruby et al., 2015) which helps ensure

that the food is not deemed unacceptable due to posing a 'danger', as Danger is a confounding form of food rejection (Rozin & Fallon, 1987).

The effectiveness of the educational information to reduce feelings of disgust was measured in isolation from negative affect in general due to the inclusion of a Threat condition designed to induce threat, similar to Hunt et al (2017). Threat was used as a negative arousal control as there is some evidence that threat has opposite effects on tactile sensitivity compared to disgust, which allows a double dissociation (e.g. Kelley & Schmeichel, 2014). Other conditions included a Control condition where participants were told they were eating regular chickpea falafels and a Mealworm condition where participants were asked to consume falafels that supposedly contained mealworm flour. A final condition was the Mealworm + education condition in which participants were treated the same as those in the Mealworm condition, but also given the educational intervention.

The traits food neophobia, disgust sensitivity, and sensation seeking were also measured. This was to investigate the moderating effects these traits may have on the disgust measures in the study. This was to help identify personality traits that make individuals more and less likely to feel disgust towards entomophagy. Emotional eating was measured in order to account for the role of stress in eating, as stress may be elicited in the Threat condition.

The two primary hypotheses were:

Hypothesis one = Falafel intake will decrease in the Mealworm condition in comparison to the Control, Threat and Mealworm + education conditions.

Hypothesis two = Tactile sensitivity will increase in the Mealworm condition and decrease in the Threat condition relative to the Control and Mealworm + education conditions.

Secondary hypotheses were as follows:

Hypothesis three = LtE will increase in the Mealworm condition in comparison to the Control, Threat and Mealworm + education conditions.

Hypothesis four = Liking will decrease in the Mealworm condition in comparison to the Control, Threat and Mealworm + education conditions.

Hypothesis five = DtE will decrease in the Mealworm condition in comparison to the Control, Threat and Mealworm + education conditions.

Hypothesis six = Trait disgust sensitivity will not moderate falafel intake in the Control and Threat conditions, but increased disgust sensitivity may result in lower intake in the Mealworm + education condition. Trait disgust sensitivity will moderate falafel intake in the Mealworm condition such that an increase in disgust sensitivity will result in decreased intake.

Hypothesis seven = Trait sensation seeking will not moderate falafel intake in the Control and Threat conditions but may in the Mealworm and Mealworm + education conditions - such that an increase in sensation seeking will lead to falafel intake not differing from pre-manipulation measures.

Hypothesis eight = Trait food neophobia will not moderate falafel intake in the Control and Threat conditions but may in the Mealworm + education and Mealworm conditions - such that an increase in food neophobia will result in reduced intake.

Hypothesis nine = Trait emotional eating may moderate falafel intake in the Threat condition, such that an increase in emotional eating will result in increased intake, but will not moderate intake in the Control, Mealworm or Mealworm + Education conditions.

## **3.2 Method**

### **3.2.1 Participants and recruitment.**

104 members of the public participated ( $n = 78$ , 75% Female and  $n = 26$ , 25% Male. Age: ranged from 18 – 24 years, 44.2% to 65+ years, 1.9%. BMI:  $M = 23.5$ ,  $SD = 3.6$  kg/m<sup>2</sup>) in this laboratory study in exchange for monetary reimbursement. Power analysis was done using effect sizes from measures of liking, DtE and tactile sensitivity from a previous study which used a similar design. Effect sizes for these three variables were .35, .43 and .34 respectively. Using the smallest effect size (.34) the analysis indicated that a sample of 99 would be required to achieve 80% power with an alpha of .05. As the present study was investigating an effect of manipulation on food intake the number of participants was increased to 104 which also allowed an equal number of participants in each experimental group. Participants were recruited via an advert on the University webpage and through the research group mailing list. To prevent a bias in selection towards those interested in trying insect containing food, the advert merely stated that the study was investigating willingness to try 'world foods'. Participants were all non-vegan or vegetarian, did not have any food allergies or intolerances and were not on a diet to lose weight. The study was granted ethical approval by the University of Bristol Ethics Committee (approval code: 22031861441).

### **3.2.2 Design.**

A two-session, single-blind, between-subjects design was used in this study. The independent variable was the experimental condition, of which there were four: Control,

Mealworm, Mealworm + education and Threat. The dependent variable was the disgust response determined using measures of tactile sensitivity, falafel intake, LtE, liking and DtE. During session one, participants were served an ad libitum portion of falafel and pitta bread. This session was included in order to measure individual differences in amounts of falafel and pitta bread typically consumed by the participants under standard conditions. The results were used as control variables (covariates) in the analyses of the effects of the subsequent manipulations on falafel and pitta intakes. Participants were randomly assigned to one of the four conditions. There was an equal number of participants in each condition ( $n = 26$ ). As two types of falafel were used in this study, one in each session, falafel type was counterbalanced.

### **3.2.3 Condition narratives.**

The experimental conditions differed only on the content of a 320-word passage included in a study booklet, along with all of the written measures. The passages used are shown in Appendices B – E. Each condition was associated with a different passage that was read after the first tactile sensitivity measure in session two.

#### **3.2.3.1 Control Condition.**

The Control passage informed participants that the falafels they were eating that day were made with different herbs and spices to the falafel they ate during session one. It then went on to discuss, methodically, the process by which herbs and spices are produced. This was intended to be affectively neutral.

#### **3.2.3.2 Mealworm Condition.**

The Mealworm passage began by informing participants that the falafels they were eating that day were made from 50% chickpeas and 50% dried mealworm flour – this was not true; they did not contain mealworms and were the same falafels given to those in all other conditions. The passage went on to discuss the process by which mealworm flour is produced, again in a methodical and factual way that was intended to be affectively neutral.

#### ***3.2.3.3 Mealworm + education Condition.***

The Mealworm + education passage began using the same words as the Mealworm passage, so informed participants that the falafels contained mealworm flour – again, this was not true. The passage went on to discuss two main advantages of eating mealworms (the benefits of superior environmental sustainability compared to conventional meat and nutritional value), the use of insect rearing to help the livelihoods of many and then highlighted that mealworms are reared in hygienic conditions fit for human consumption. This was intended to emphasise the advantages of eating mealworms and lead to positive affect towards mealworm consumption.

#### ***3.2.3.4 Threat Condition.***

This passage began using the same words as the control passage so merely stated that the falafels to be eaten that day had been made with different herbs and spices to those in session one. As this condition was intended to induce ‘imminent mild threat’ the passage informed participants that they would be required to have a tongue biopsy to obtain a sample of their tongue tissue - this was not true. This method was chosen on the basis of the results from Experiment One. The passage included a cover story about the decline of taste buds associated with ageing and its effect on taste perception. The process by which tongue biopsies occur was then explained factually.

### **3.2.4 Randomisation.**

An assistant not involved in participant testing produced four equal piles of test booklets, one for each condition, and placed them in unique locations in a cupboard. These locations remained the same throughout the duration of testing and which pile corresponded to which condition was not revealed to the experimenter until testing was complete. The locations were labelled A, B, C and D. Typically 16 participants completed session two each week. At the beginning of each week the experimenter would collect four booklets from each pile and place them in order from A on the left to D on the right. Each participant had their unique participant number inputted into an excel file. Each participant number was assigned a random number between zero and one using the random number generator function. Participants with the four lowest random numbers were assigned to condition 'A', participants with the second four lowest random numbers were assigned to condition 'B' and so on. The number of booklets left over in the original piles was carefully monitored by the experimenter to ensure that there was an equal number of people in each condition throughout testing. The condition that each booklet represented was not clear on the outside of the booklet, hence the experimenter being able to handle them.

### **3.2.5 Measures and materials.**

#### **3.2.5.1 Primary Measures.**

##### **3.2.5.1.1 Tactile Sensitivity – Semmes-Weinstein Monofilaments.**

Tactile sensitivity measures were taken twice: pre- and post-manipulation (the manipulation was reading the passage of text corresponding to condition) within session

two. Semmes-Weinstein monofilaments were used which range in force from 0.0008g to 6.0g. They are thin pieces of nylon fibre that are typically used in clinical settings. The standard procedure for applying monofilaments was followed. They were applied to the underside of the participants non-dominant forearm when rested against a table and all jewellery removed. Care was taken to ensure that the monofilament was placed in the same location for both the pre- and post-manipulation measures and that this was an area of the arm not obstructed by hair. The filaments were pressed onto the arm until they created a 'C' shape. The process began with the lowest weighted filament (0.0008g) and ended when the participant reported sensing the filament. A large cardboard screen with a hole for the arm was placed between the experimenter and the participant to ensure participants did not see the filaments being pressed onto their arm. Similarly, soft material was placed on the table to ensure participants could not hear the filaments being put down and thus be prompted to expect sensation.

#### *3.2.5.1.2 Food intake*

Food intake was measured in both session one and session two after participants had eaten from ad libitum portions. This was done using calibrated food scales. Two different flavours of falafel were served to participants over the study, and white flour pitta bread. Pitta bread was Sainsbury's own brand of 'Sainsbury's White Pitta'. Due to a fire in the factory producing the falafels initially used in the study four types of falafel were used in total, but each participant only had two over the course of the experiment. Initially, Cauldron falafels were used in the flavours: 'Original' and 'Moroccan Spiced'. Following the fire in the Cauldron factory, these were replaced with sensorially matched equivalents from the brand 'Gosh!' in the flavours: 'Original' and 'Moroccan Spiced'. These were chosen due



to containing a large number of the same ingredients as the Cauldron falafels – there was no evidence that the falafels differed to a degree large enough to affect the results of the study. Participants were served 485 g of water, 200 g falafels (approximately six falafels) cut in half and 120 g pitta bread (approximately two pitta breads; measured to the nearest .1 g) cut into inch wide slices - this was to ensure participants were not encouraged to consume more simply in order to finish the piece of pitta bread or falafel. Quantities served were determined on the basis of the previous NBU study using a similar design. The portion was re-weighed after participants had consumed as much as they wished, in order to calculate food intake. No participant refused to eat the falafels.

### ***3.2.5.2 Secondary Measures.***

#### ***3.2.5.2.1 LtE – Stopwatch.***

LtE was defined as the time taken between experimenter verbally signalling that participants can begin eating, to them taking the first bite of falafel. LtE measures were taken in both session one and two when participants first tasted the falafel. For measures of LtE an online stopwatch was used (found at: [www.estopwatch.net](http://www.estopwatch.net)), chosen due to its high precision.

#### ***3.2.5.2.2 Liking and DtE – 100mm length scales.***

Self-report food liking (taste pleasantness) and DtE were measured in both sessions after the first taste of both falafel and pitta bread. Participants were verbally instructed to take a single bite of each of the two foods and rate their liking and DtE on the scales in front of them. Measures were obtained through vertical marks made by participants on 100mm

horizontal lines anchored 'Not at all' and 'Extremely', assessing liking and DtE based on a single bite of food, based on those used by (Rogers & Hardman, 2015).

#### *3.2.5.2.3 Personality Questionnaires.*

Four personality questionnaires were used in this study. They were completed towards the end of session two. Emotional eating was measured using the Dutch Eating Behaviour Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) which consists of 33 items rated on a 5-point scale. This scale had excellent internal consistency ( $\alpha = .92$ ). Food neophobia was measured using the Food Neophobia Scale (Pliner & Hobden, 1992) which consists of 10 items scored on a 7-point Likert-type scale. The internal consistency of this scale was good ( $\alpha = .88$ ). Disgust sensitivity was measured using the Disgust Sensitivity-Revised scale (DS-R; Olatunji et al., 2007). This consists of 25 items which cover three domains of disgust (core, animal reminder and contamination) scored on a 7-point Likert-type scale. This scale had an acceptable level of internal consistency ( $\alpha = .77$ ). Sensation seeking was measured using the Revised Sensation Seeking Scale (Zuckerman, 1979). It was adapted to be more relevant to today's participants (one question was omitted for politically incorrect content; alternative wording was used in three questions that used outdated terminology unlikely to be understood by participants). The adapted questionnaire consisted of 39 pairs of items – participants selected one statement from each pair that they believed best represented their views. This scale had good internal consistency ( $\alpha = .81$ ).

#### *3.2.5.2.4 Self-Report Disgust and Nervousness – 100mm length scales.*

At the end of session two participants were asked explicitly to retrospectively report their feelings of disgust when asked to eat: 1. Falafel and 2. Pitta bread. This was scored with a vertical mark on a 100mm horizontal line anchored 'Not at all' and 'Extremely'. Those

in the Threat condition were then asked to rate on identical scales the extent to which they felt: 1. Nervous and 2. Disgusted when they were told they would be having a tongue biopsy as part of the study (the method to induce threat).

### **3.2.6 Procedure.**

Participants attended the lab twice around lunch time. They were instructed to refrain from eating and drinking, other than water, for three hours prior to the test session. A diagram of the study procedure can be seen in Figure 9.

#### **3.2.6.1 Session One.**

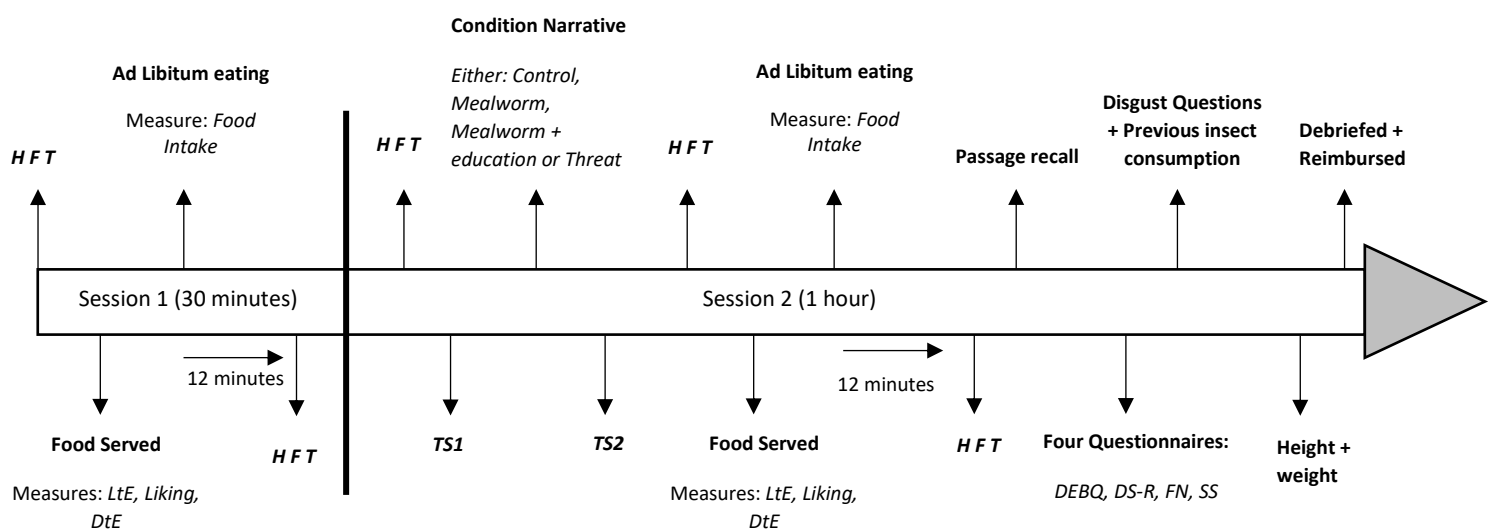
The first session lasted around 30 minutes and always took place on a Monday. Up to three participants were tested at once in the first session, all sitting in individual booths that the experimenter could observe simultaneously – this allowed 16 participants to be tested in one day. Participants first read the information sheet, asked any questions, and signed the consent form. After reporting age and gender participants completed ratings of hunger, fullness and thirst on 100mm scales anchored ‘not at all’ and ‘extremely’. Participants were then served the ad libitum portion of falafels (type 1), pitta bread and water. Participants then rated their liking and DtE the foods after taking a single bite of each. LtE was measured based on time taken to take the first bite of falafel. It was measured via direct observation from the experimenter with multiple stopwatches being used, one for each participant. Following this, participants were informed they had 12 minutes in which to eat ‘as much or as little’ of the food as they wished and they could drink ‘as much or as little’ of the water as they wished. The experimenter then left the room to allow participants

to eat comfortably. At the end of 12 minutes the experimenter returned and participants rated their hunger, fullness and thirst for a second time and were then thanked and dismissed.

#### **3.2.6.2 Session Two.**

The second session lasted around one hour and took place on Tuesday to Friday of the week following the first session. One participant was tested at a time. It began with hunger, fullness and thirst ratings. The pre-manipulation tactile sensitivity measure was then taken. Participants were then instructed to read the written passage contained within their test booklet which corresponded to their experimental condition. They were told they would be asked to recall concepts of the text later in the study to ensure they maintained focus. The post-manipulation tactile sensitivity measure followed. Participants then completed hunger, fullness and thirst scales while the experimenter collected their food for that session. Falafels (type 2), pitta bread and water were served. Following the same procedure as session one, participants were instructed to take a single bite of each food and rate their liking and DtE and LtE was measured. As in session one, participants were then informed they had 12 minutes to eat 'as much or as little' of the food as they wished and they could drink 'as much or as little' of the water as they wished. When the experimenter returned the participant was instructed to complete the final hunger, fullness and thirst ratings and to then go on to complete the rest of the booklet. This contained a section where participants were asked to briefly write down something they had learned from the passage to comply with the memory recall cover story. The booklet also included the four personality questionnaires (DEBQ, Food Neophobia, DS-R and Sensation Seeking) and two questions relating to subjective ratings of disgust. The Threat condition also included the

two questions, one about feelings of nervousness and one about disgust. These explicit questions were answered towards the end of the session when those in the Threat condition knew the tongue biopsy was not going to happen – hence being asked to reflect on their previous feelings. Finally, participants completed a demand awareness question where they were asked to write what they thought the study was about and to report the frequency of any previous instances of consuming insects. Participants' height and weight was recorded before they were reimbursed for their time, thanked, and dismissed.



**Figure 9.** Representation of the timeline of the study's procedure. H F T = Hunger, Fullness and Thirst. TS = Tactile Sensitivity. DEBQ = Dutch Eating Behaviour Questionnaire. DS-R = Disgust Sensitivity scale revised. FN = Food Neophobia. SS = Sensation Seeking.

### 3.3 Results

#### 3.3.1 Primary analyses.

##### 3.3.1.1 ANCOVAS.

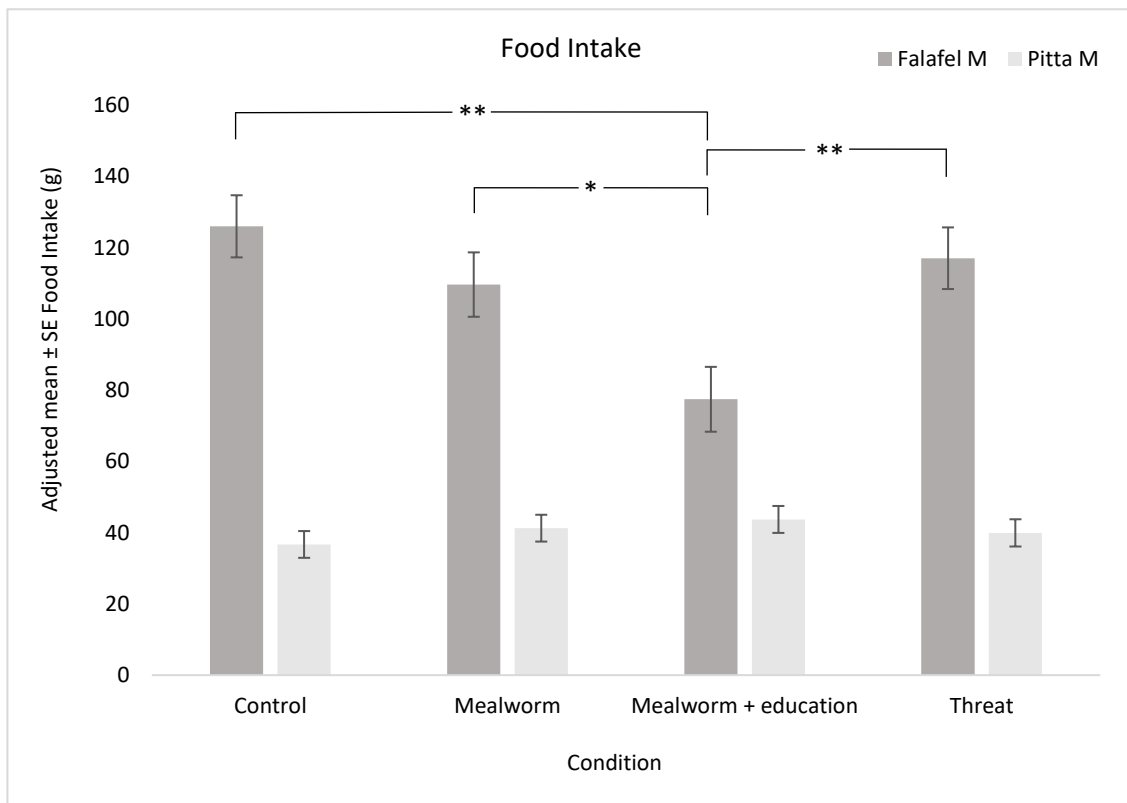
Eight ANCOVAS were conducted to compare the post-manipulation measure of each dependent variable (falafel intake, pitta bread intake, tactile sensitivity, LtE, Liking falafel, Liking pitta, DtE falafel, DtE pitta) between the four conditions, with the pre-manipulation measure of each dependent variable entered as a covariate in the analysis model.

Six participants were excluded from the falafel intake ANCOVA, leaving 98, though the pattern of results did not significantly change with or without participant exclusions. One participant had a z-score that was outside a pre-defined acceptable range ( $z > 3.29$  or  $z < -3.29$ ). Three participants verbally informed the experimenter that they perceived eating insects as normal and did not find it disgusting, and two participants were given the incorrect flavour of falafel due to falafel shortages. ANCOVAs revealed there was a significant effect of condition on falafel intake in session two, but there was not a significant effect of condition on pitta bread intake in session two (test statistics shown in Table 1). Post hoc tests showed that falafel intake was significantly lower in the Mealworm + education condition than the Control, Mealworm and Threat conditions (Figure 10). Correction for multiple comparisons was not used as Bonferroni can over correct and can lack sensitivity to effects (Nakagawa, 2004; Perneger, 1998). Also, the difference in the pattern of results with and without Bonferroni correction was minimal and therefore deemed unnecessary. Five participants were excluded from tactile sensitivity analysis, two due to having z-scores that were outside the defined acceptable range, and three for informing the experimenter that they perceived eating insects as normal, leaving a total of

99. The ANCOVA revealed there was not a significant effect of condition on the post-manipulation measure of tactile sensitivity (Table 1 and Figure 11). The mean pre-manipulation measure of tactile sensitivity was .082 ( $SD = .13$ ) and the mean post-manipulation measure was .074 ( $SD = .10$ ).

**Table 1.**  
*Test statistics for the eight ANCOVA models.*

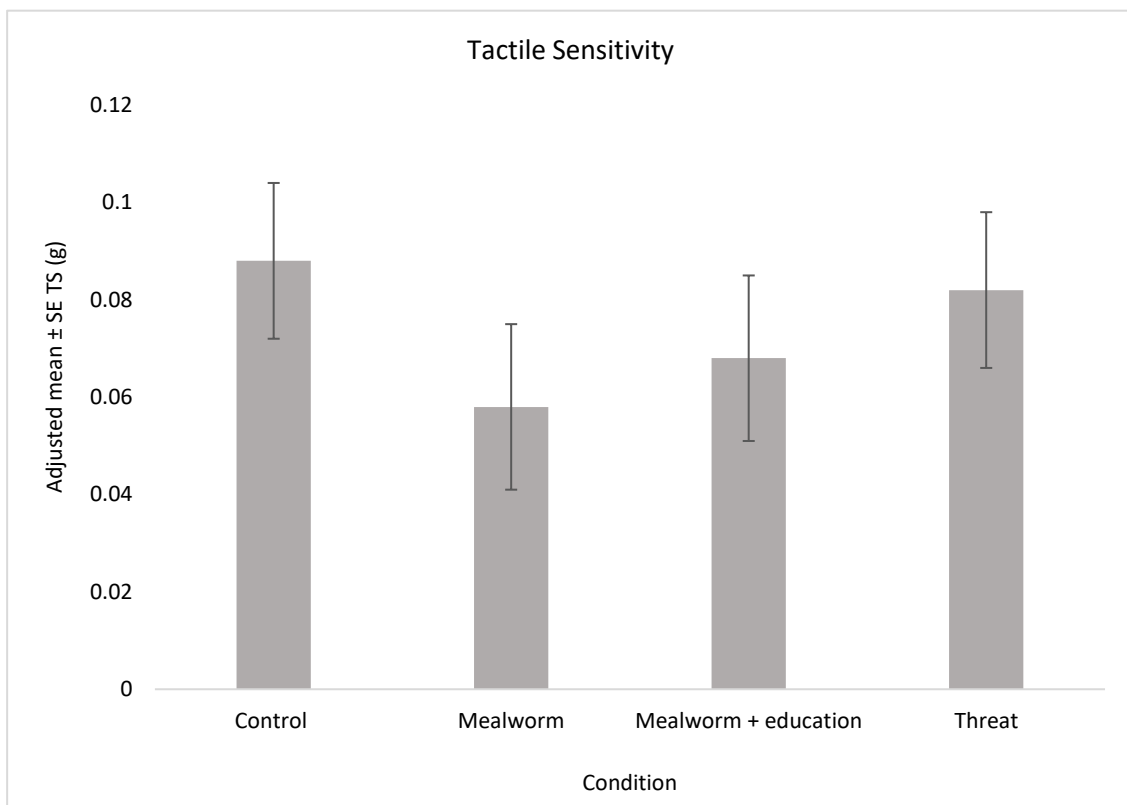
Dependent Variable	Test Statistic				
	F	df	Error	<i>p</i> -value	Partial $\eta^2$
Falafel Intake	5.570	3	93	.001	.152
Pitta Intake	.599	3	98	.617	.018
Tactile sensitivity	.685	3	94	.563	.021
LtE	.987	3	94	.402	.031
Liking falafel	4.855	3	94	.003	.134
DtE falafel	6.805	3	94	< .001	.178
Liking Pitta	.613	3	99	.608	.018
DtE Pitta	.149	3	99	.930	.005



**Figure 10.** Graph showing adjusted means for food intake and standard error.

\* =  $p < .01$

\*\* =  $p < .05$



**Figure 11.** Graph showing adjusted means for Tactile Sensitivity with standard error.

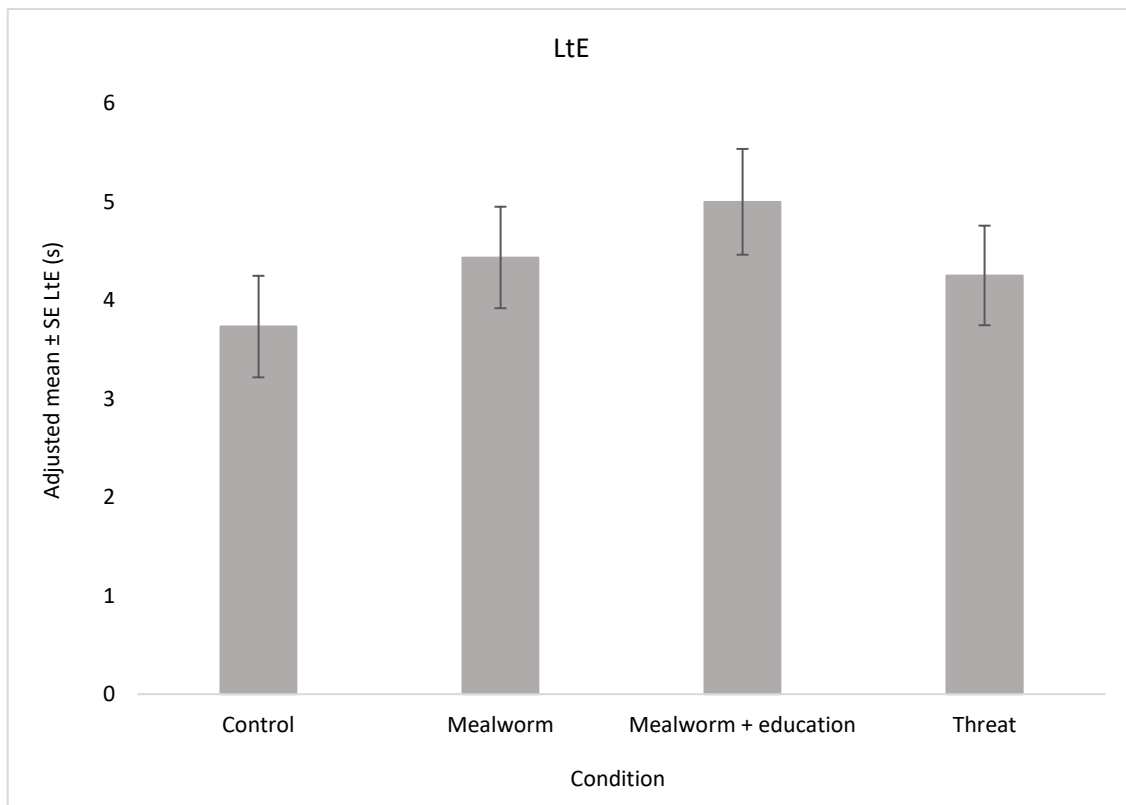


### **3.3.2 Secondary analyses.**

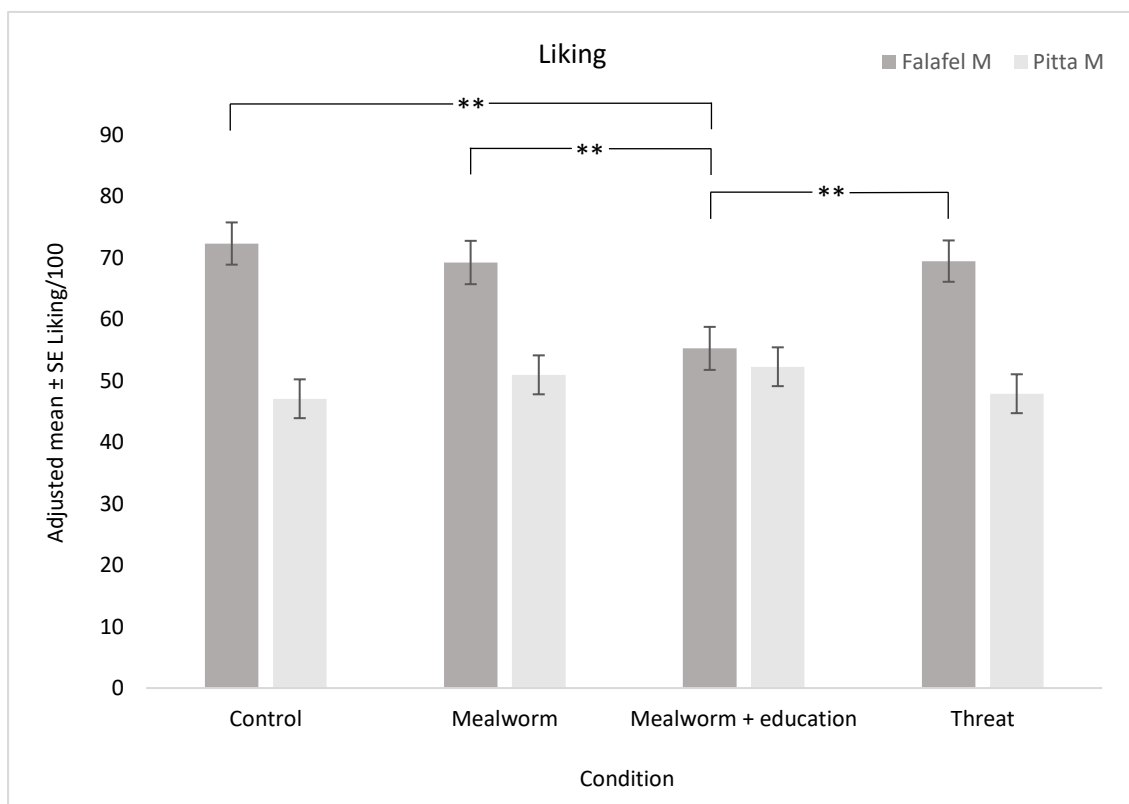
#### **3.3.2.1 ANCOVAS.**

Five participants were excluded from LtE analysis. One was recorded incorrectly, one had a z-score that was outside the defined acceptable range, and three informed the experimenter that they perceived eating insects as normal, leaving a total of 99. The ANCOVA revealed there was not a significant effect of condition on LtE in session two (Table 1 and Figure 12). Five participants were excluded from falafel liking analysis. Two had been given the wrong flavour of falafels and three informed the experimenter that they perceived consuming insects as normal, leaving a total of 99. ANCOVA analysis revealed there was a significant effect of condition on liking ratings of falafel in session two, however there was not a significant effect of condition on ratings of liking for pitta bread in session two (Table 1). Post hoc tests revealed that liking ratings of falafels in session two were significantly lower in the Mealworm + education condition compared to all other conditions (Figure 13). Five participants were excluded from falafel DtE analysis for the same reasons as the liking data, leaving a total of 99. ANCOVA analysis revealed there was a significant effect of condition on DtE ratings of falafel in session two, however there was not a significant effect of condition on ratings of DtE pitta bread in session two (Table 1). Post hoc tests revealed that DtE falafel was significantly less in the Mealworm + education condition than in the other three conditions (Figure 14).

A separate analysis was run using a mixed measures model ANCOVA to test a food (pitta bread and falafel) by condition effect for intake, DtE and liking. This revealed a significant food by condition interaction effect for all three measures ( $p's < .002$ ).

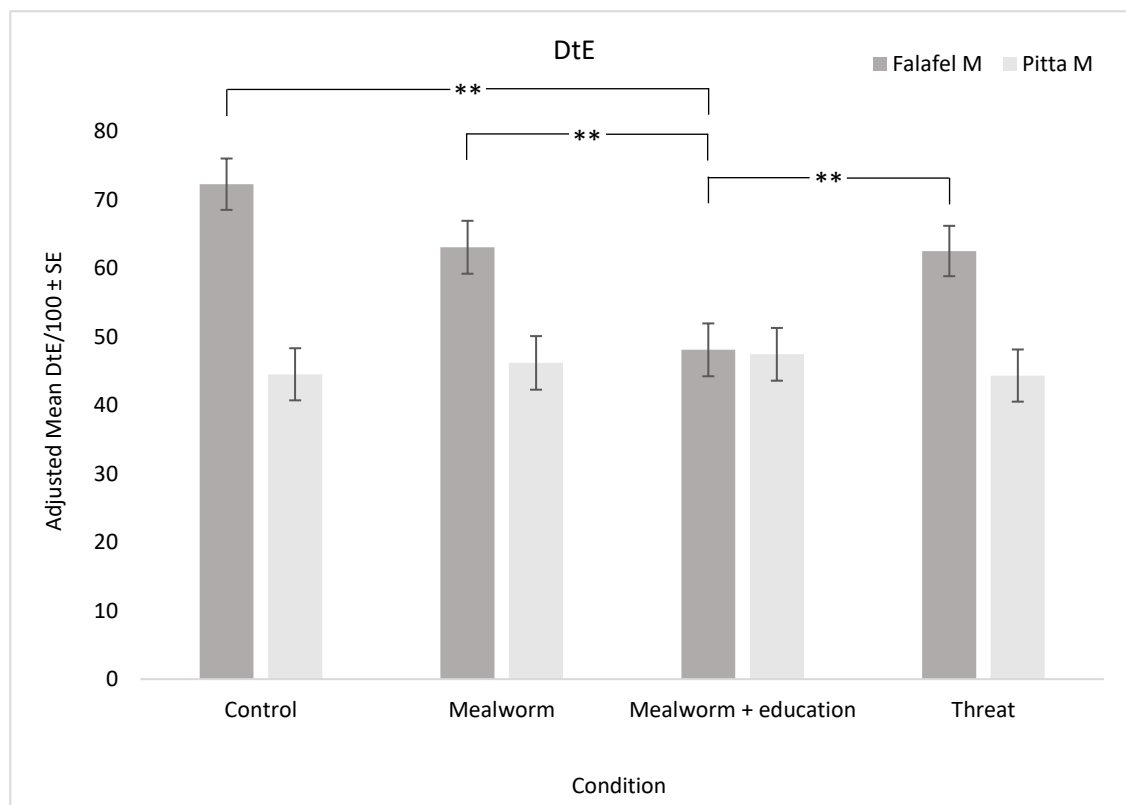


**Figure 12.** Graph showing adjusted means for LtE and standard error.



**Figure 13.** Graph showing adjusted means for liking of falafel and pitta bread with standard error bars.

\*\* =  $p < .01$



**Figure 14.** Graph showing adjusted means for DtE falafel and pitta bread with standard error bars.

\*\* =  $p < .01$

### 3.3.2.2 Multiple Regression.

16 multiple regression models were run. Table 2 outlines the predictor and outcome variables of each model. Each model aimed to determine the extent to which: falafel intake in session one, trait 'A' (either: disgust sensitivity, sensation seeking, food neophobia or emotional eating) and a condition 'A' (either: Control, Mealworm, Mealworm + education or Threat) X trait 'A' interaction term (predictor variables) accounted for variance in falafel intake in session two (outcome variable). As there were four conditions and four traits assessed there was a total of 16 regression models each with a unique condition X trait interaction term. Descriptive statistics of the trait measures can be seen in Appendix H. Trait

disgust sensitivity, sensation seeking and emotional eating and their associated interaction terms did not significantly predict falafel intake in session two. (Table 3). Trait food neophobia was a significant predictor of falafel intake in session two in all four regression models that included it (Table 3). Of the four interactions only food neophobia X Mealworm + education condition was significant.

This interaction was investigated as part of exploratory analysis. Food neophobia scores were divided into 'high' and 'low' scores after ranking them in ascending order to achieve a median split. This variable of food neophobia was inputted to an ANCOVA model as a fixed factor along with the Mealworm + education condition. Falafel intake in session two was the dependent variable and falafel intake in session one was the covariate. A plot was produced to visualise the interaction between the Mealworm + education condition and trait food neophobia (Figure 15). A significant interaction was shown as falafel intake was reduced more among participants who were 'high' in food neophobia in the Mealworm + education condition versus the other conditions, compared with those who were low in food neophobia ( $F(1,99) = 6.21, p = .01, \eta_p^2 = .06$ ).

**Table 2.***The 16 multiple regression models.*

Model	Predictor Variables			Outcome Variable
	Constant	Raw data	Interaction term	
Disgust Sensitivity				
1. Control	Falafel intake session one	DS Raw	DS X Control interaction	Falafel intake session two
2. Mealworm	Falafel intake session one	DS Raw	DS X Mealworm interaction	Falafel intake session two
3. M + E	Falafel intake session one	DS Raw	DS X M + E interaction	Falafel intake session two
4. Threat	Falafel intake session one	DS Raw	DS X Threat interaction	Falafel intake session two
Sensation Seeking				
5. Control	Falafel intake session one	SS Raw	SS X Control interaction	Falafel intake session two
6. Mealworm	Falafel intake session one	SS Raw	SS X Mealworm interaction	Falafel intake session two
7. M + E	Falafel intake session one	SS Raw	SS X M + E interaction	Falafel intake session two
8. Threat	Falafel intake session one	SS Raw	SS X Threat interaction	Falafel intake session two
Food Neophobia				
9. Control	Falafel intake session one	FN Raw	FN X Control interaction	Falafel intake session two
10. Mealworm	Falafel intake session one	FN Raw	FN X Mealworm interaction	Falafel intake session two
11. M + E	Falafel intake session one	FN Raw	FN X M + E interaction	Falafel intake session two
12. Threat	Falafel intake session one	FN Raw	FN X Threat interaction	Falafel intake session two
Emotional Eating				
13. Control	Falafel intake session one	EE Raw	EE X Control interaction	Falafel intake session two
14. Mealworm	Falafel intake session one	EE Raw	EE X Mealworm interaction	Falafel intake session two
15. M + E	Falafel intake session one	EE Raw	EE X M + E interaction	Falafel intake session two
16. Threat	Falafel intake session one	EE Raw	EE X Threat interaction	Falafel intake session two

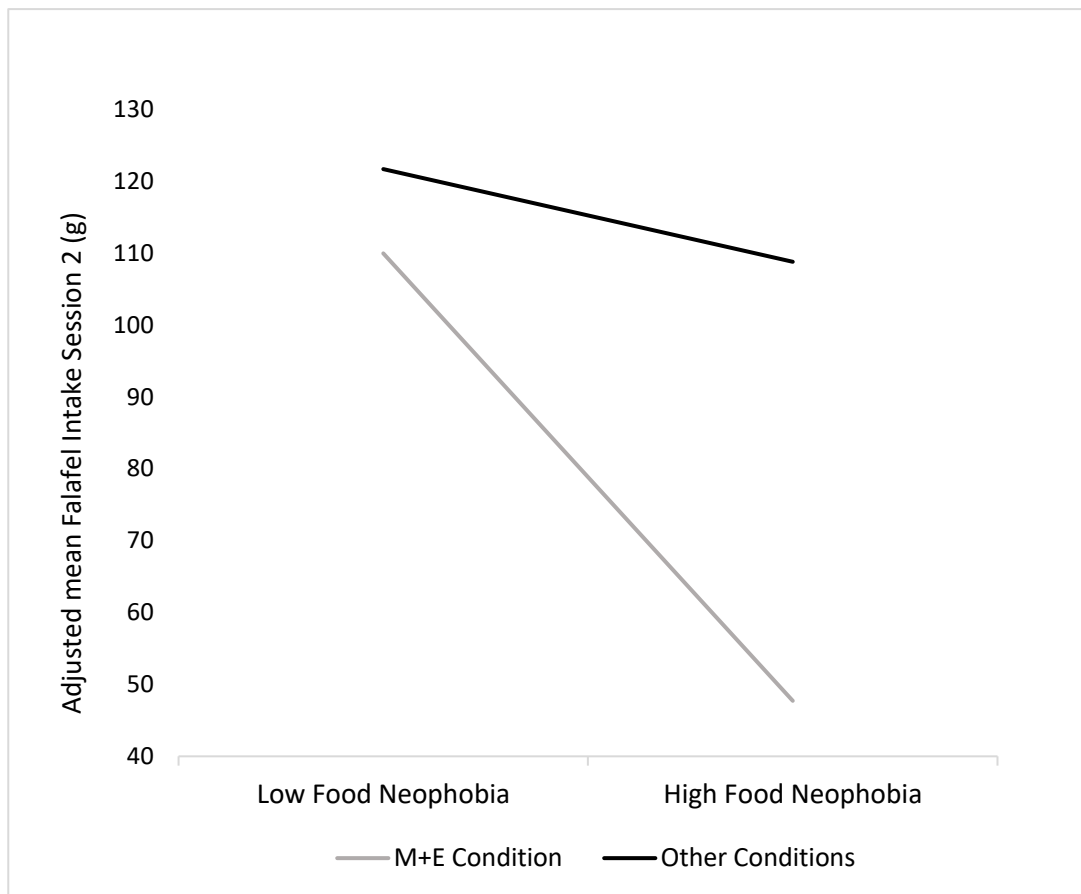
*Note.* M + E = Mealworm + education.

**Table 3.**

*Results of the multiple regression analysis. Every condition and personality trait is displayed.*

Disgust Measure (split by condition)		Falafel intake predictors (split by trait)							
		Disgust Sensitivity		Sensation Seeking		Food Neophobia		Emotional Eating	
		Trait X condition interaction	Trait	Trait X condition interaction	Trait	Trait X condition interaction	Trait	Trait X condition interaction	Trait
Falafel Intake S2	Control	-.028 ( <i>p</i> = .74)	-.040 ( <i>p</i> = .64)	-.087 ( <i>p</i> = .32)	.094 ( <i>p</i> = .28)	.016 ( <i>p</i> = .85)	-.317 ( <i>p</i> < .01)	-.043 ( <i>p</i> = .62)	-.081 ( <i>p</i> = .36)
Falafel Intake S2	Mealworm	.007 ( <i>p</i> = .93)	-.043 ( <i>p</i> = .62)	-.033 ( <i>p</i> = .70)	.093 ( <i>p</i> = .29)	.065 ( <i>p</i> = .42)	-.327 ( <i>p</i> < .01)	-.122 ( <i>p</i> = .18)	-.117 ( <i>p</i> = .20)
Falafel Intake S2	M + E	-.102 ( <i>p</i> = .25)	-.065 ( <i>p</i> = .46)	.108 ( <i>p</i> = .22)	.154 ( <i>p</i> = .08)	-.202 ( <i>p</i> = .01)	-.300 ( <i>p</i> < .01)	.055 ( <i>p</i> = .55)	-.098 ( <i>p</i> = .29)
Falafel Intake S2	Threat	.106 ( <i>p</i> = .22)	-.041 ( <i>p</i> = .63)	-.020 ( <i>p</i> = .82)	.090 ( <i>p</i> = .31)	.119 ( <i>p</i> = .14)	-.324 ( <i>p</i> < .01)	.082 ( <i>p</i> = .35)	-.068 ( <i>p</i> = .44)

*Note.* Table is showing standardised beta coefficients. S2 = session two. M + E = Mealworm + education.



**Figure 15.** Significant interaction between food neophobia and the Mealworm + education condition. Adjusted mean falafel intake in session two is displayed.

### 3.3.2.3 One-way ANOVA.

A one-way ANOVA was used to investigate self-report disgust. It revealed a significant effect of condition on self-reported disgust when asked to eat the falafel in session two ( $F(3,100) = 16.14, p < .01, \eta_p^2 = .33$ ). The highest rating of self-reported disgust was in the Mealworm + education condition, followed by Mealworm, then Threat then Control (Table 4). Self-reported disgust did not significantly differ between the Mealworm and Mealworm + education conditions (Table 4). A one-way ANOVA revealed that there was not a significant effect of condition on self-reported disgust when asked to eat the pitta in session two ( $F(3, 100) = 1.47, p = .23, \eta_p^2 = .04$ ).

### 3.3.2.4 Paired Samples t-test.

A paired samples t-test revealed that there was not a significant difference between self-report nervousness ( $M = 27.56, SD = 25.47$ ) and self-report disgust ( $M = 21.45, SD = 27.10$ ) when rating these emotions on the basis of the prospect of having a tongue biopsy ( $t(25) = 1.30, p > .05$ ).

**Table 4.**

*Mean self-report ratings of disgust at prospect of eating falafel in session two in each of the four conditions.*

	Condition							
	Control		Mealworm		Mealworm + education		Threat	
	M	SD	M	SD	M	SD	M	SD
Self-Report Disgust (max = 100)	2.77 <sup>a</sup>	3.5	33.34 <sup>b</sup>	30.06	42.51 <sup>b</sup>	31.87	9.44 <sup>a</sup>	19.53

*Note.* Means not sharing a superscript letter in common (a, b) differ significantly ( $p < .01$ ).



### 3.4. Discussion

#### 3.4.1 Present findings.

Contrary to hypotheses one, four and five, the largest disgust response was exhibited in the Mealworm + education condition, rather than the Mealworm condition. Participants in the Mealworm + education condition consumed less falafel and had reduced liking and DtE the falafel compared to those in the Control, Mealworm and Threat conditions. They also self-reported higher feelings of disgust than those in the Control and Threat conditions, though interestingly, self-report disgust was *not* significantly different to that in the Mealworm condition. In stark contrast, falafel intake, liking and DtE, unexpectedly, did not differ between the Control and Mealworm conditions. There were no differences between conditions for pitta bread intake, liking, DtE and self-report disgust. These results for pitta bread were expected and show that the differences for falafel were specific to the mealworm flour manipulation. These findings are of particular importance because it is the first time, to my knowledge, that disgust towards insect containing food has shown significant effects on food intake.

The results lead to the rejection of the second primary hypothesis. A potential cause for the lack of significant difference in the post-manipulation tactile sensitivity measure between the conditions could be due to warm body temperature leading to inconsistent skin sensitivity (B. G. Green, 1977; B. Green, Lederman, & Stevens, 1979). Evidence of differences in finger temperature due to current affective state (e.g. Levenson, Carstensen, Friesen, & Ekman, 1991) suggests that temperature is critically important when investigating differences in tactile sensitivity (Kelley & Schmeichel, 2014). The study took place over the

summer months when England was experiencing a heatwave meaning many participants were visibly hot when attending study sessions. Tactile sensitivity was relatively high (low values indicate a higher sensitivity) in the present study for both the pre- and post-manipulation measures when compared to previous work in the NBU. Previously, mean tactile sensitivity was .17 ( $SD = .30$ ) for the pre-manipulation measure and .15 ( $SD = .16$ ) for the post-manipulation measure. In the present study, the mean pre-manipulation measure of tactile sensitivity was .082 ( $SD = .13$ ) and the mean post-manipulation measure was .074 ( $SD = .10$ ). This signifies a floor effect as these measures were among the lower end of the monofilament's sensitivity. Perhaps, due to the hot temperature, participants skin sensitivity was heightened and that led to the lighter monofilaments not being precise enough to detect changes in tactile sensitivity. An additional reason could be that while it is highly important that monofilaments are applied accurately, measures are taken by hand and are therefore open to human error.

The third hypothesis can be rejected as there was not a significant effect of condition on the post-manipulation measure of LtE. As LtE was largely an exploratory measure and the pattern of LtE was in-keeping with the pattern of results for falafel intake, liking and DtE, it may be beneficial for future research to investigate this measure again with a more precise measurement technique. For example, videoing participants eating so that LtE can be more carefully calculated after the testing session in order to reduce the effect of in-the-moment human error.

The present findings support the eighth hypothesis. Trait food neophobia moderated falafel intake in session two. It is especially notable that those who were high in food neophobia were most affected in the Mealworm + education condition (lowest food intake).

Food neophobia has previously been found to be an important measure in food-related disgust research as it is often associated with attitudes towards novel foods such as insects (Caparros Megido et al., 2014; Shan, Tan, Van Den Berg, & Stieger, 2016; Siegrist, Hartmann, & Keller, 2013). When profiling consumers who are willing to adopt entomophagy it has been found that food neophobia made the largest contribution to this willingness; such that a one unit increase in food neophobia is associated with an 84% decrease in willingness to consume insects (Verbeke, 2015). The current findings, that food neophobia was the only trait that moderated differences in consumption between the four conditions, and furthermore predicted overall falafel intake, support the claims that it is a key measure to include in food-related disgust research.

Hypotheses six, seven and nine are not supported by the results. The lack of moderating effects of disgust sensitivity and sensation seeking could be due to the scales not relating to a food specific trait. In both questionnaires, few, if any, questions relate to food. Emotional eating was included as restrained eaters overeat in response to stress (Heatherton et al., 1991; Herman et al., 1987; Wallis & Hetherington, 2004), which is associated with threat, the state induced in the Threat condition. The lack of moderating effects of emotional eating is perhaps then unsurprising given the dependent measures in the Threat condition were not different from Control, that is, because participants did not feel threatened. This is supported further by the fairly low self-reported nervousness (and disgust) at the prospect of the tongue biopsy. Future research might consider a more impactful threat induction method, perhaps using videos as this has shown to be effective in the past (e.g. Hunt et al., 2017).

### 3.4.2 Disgust response.

Despite the only implicit measure of disgust response (tactile sensitivity) showing no significant effects and the lack of difference in self-report disgust between the two mealworm conditions, there remains substantial evidence that the emotion that led to food rejection in this study was disgust. Rozin & Fallon (1987) define disgust as a combination of distaste and ideational factors. There is evidence from the present data that these two factors have led to the food rejection in the Mealworm + education condition which means the cause is disgust. First, as the same falafels were given in every condition it seems very unlikely that the reduction in intake in the Mealworm + education condition can be attributed to genuine sensory inferiority of the falafels in that condition. It is therefore highly likely that the food rejection originated solely from the only manipulation that was implemented: knowledge (ideation) that the falafels contained mealworm flour. Second, liking is a measure of distaste and it decreased in the Mealworm + education condition. Finally, there was an increase in self-reported disgust for the falafels in both the Mealworm + education and Mealworm conditions

This idea could extend to the suggestion that ideation *causes* distaste. The present design manipulated only ideation by giving those in the two mealworm conditions the false knowledge that the falafels contained mealworm flour, while taste remained the same across conditions. Following this, liking, DtE and intake, of falafel in the Mealworm + education condition were significantly reduced. This indicates that the ideation caused the distaste, shown by the reduction in liking. That the measures of liking, DtE and intake were similarly affected by the manipulation is perhaps unsurprising when these results are considered within the context of the Rogers & Hardman (2015) model of food reward. This

model depicts liking as a component, and driver, of food reward (measured by DtE) and food reward as a driver of intake. The present data are consistent with a decrease in liking driving a decrease in food reward and consequently a decrease in intake.

If ideation causes distaste then it is important to consider how the condition passages changed ideation over time and how this had an effect on the measures in both mealworm conditions. It may be reasonable to suggest that initially the ideation in both mealworm conditions was the same (falafels contain mealworm flour), and negative. In the Mealworm condition the passage that followed changed this ideation to be more positive, perhaps because it discussed cooking mealworms to produce mealworm flour. This in-the-moment change in ideation meant that participants had relatively positive ideation when tasting and rating the falafels and when they consumed as much as they wished, hence the lack of difference in these measures between the Mealworm and Control conditions. In contrast, in the Mealworm + education condition the information provided in the passage did not lead to positive ideation. Perhaps because the topics of sustainability and nutrition are not specific enough to the food, and/or perhaps the discussion of hygiene paradoxically led to participants doubting the food's cleanliness. Therefore, among participants in this condition negative ideation prevailed when tasting and consuming the falafel, causing reduced liking (i.e. increased distaste) and ultimately reduced intake.

The concept of in-the-moment changes in ideation could explain the incongruence between self-reported disgust and liking, DtE and intake measures in the Mealworm condition. In this condition participants self-reported levels of disgust that were not significantly different to those reported in the Mealworm + education condition despite the higher ratings of liking and DtE and increased intake. The self-report question asked how

disgusted participants felt when first asked to eat the falafel in the study. In this context perhaps participants attended to (recalled) their disgust associated with consuming insects in general rather than the information that, in the case of the Mealworm condition, led to a more positive ideation during the earlier tasting and eating. This subsequent attention to the general idea of eating insects resulted in a rating of self-reported disgust that was not different to that in the Mealworm + education condition. Alternatively, rather than evidence for the existence of in-the-moment disgust ideation, the finding might be understood as a demand characteristic. That is, participants felt they *should* have felt disgusted by eating supposed mealworm containing falafels. Never-the-less, the incongruence between self-reported disgust measures and liking, DtE and intake measures demonstrates the importance of measuring actual behaviour (in this case food intake), as self-reported attitude does not mirror the behavioural response. This finding supports other authors who stress this importance and describe the incongruence as the Attitude-Behaviour Gap (Ajzen, 2001; Kraus, 1995; Schlup & Brunner, 2018; Vermier & Verbeke, 2006).

### **3.4.3 Effectiveness of educational interventions.**

The surprising, yet consistent, pattern of results in the present study demonstrates robustly that the text included in the Mealworm + education passage did not reduce the disgust response. Promoting a novel food on the basis of rational arguments, as the Mealworm + education passage did, has been deemed ineffective in other studies (e.g. Edwards, 1990; Grob, 1995; Hartmann et al., 2015; Hartmann & Siegrist, 2016; Sheppard & Frazer, 2015), and the present findings support this claim. Consumer acceptance of alternative proteins has been found to be determined by attitudes, beliefs and sensory

attractiveness of the food. For this reason, it is suggested that arguments to make alternative proteins appear more attractive should not be grounded in ethics alone (Hoek et al., 2011). This suggestion is supported by a study which profiled those who self-report a high willingness to consume insects. It was found that health benefits only played a marginal role in willingness to consume insects and environmental concern was not a primary focus of participants when purchasing food (Verbeke, 2015). It is especially difficult for a rational argument to affect behaviour when there is a disconnect between the perceived relevance of arguments and an individual's decision to consume insects (Schlup & Brunner, 2018).

In a similar vein, recent studies have claimed that information cannot be used to alter *emotion*, though self-reports of *sensory judgements* can be affected by the provision of information. One study investigated how participants evaluated the 'appropriateness' of cricket containing buns when given either negative, positive (including nutritional and environmental advantages) or neutral information. The effect of this information on participants' sensory judgements and emotions was measured. Information affected sensory evaluations before actual tasting of the food, with the negative information leading to significantly lower perceptions of various sensory attributes than the positive or control information. However, information did not lead to differences in *emotions* across the groups (Pambo et al., 2018). Similarly, Schouteten et al. (2016) found that the provision of information about the benefits of entomophagy influenced overall liking of the food but did not affect emotional conceptualisations. These findings are in-keeping with the findings of the present study as educational information was unable to prevent an increase in emotion (disgust), though in the present study it also did not prevent a decrease in the sensory judgement of liking.

It has also be argued that food choices cannot be altered by rational arguments due to their basis in sensory experience (Hamerman, 2016; Manditsera et al., 2018; Myers & Pettigre, 2018; Shan et al., 2015; Sogari et al., 2017, 2018). In 2015 van Huis claimed that stressing the health and environmental benefits of eating insects is insufficient to encourage consumption as acceptability is also rooted in deliciousness of the food (van Huis, 2015). Sensory perception of insect containing food needs to be enhanced if its consumption is to become widespread. Deroy, Reade, and Spence (2015) argue that this is the case because rational arguments can only successfully increase the consumption of insects if the reluctance to consume them is based in cognition, however, if the reluctance is based in disgust (a widely accepted claim) it would be immune to rationality, hence the importance of increasing the sensory perception.

#### **3.4.4 Reduced disgust response in the mealworm condition.**

It is highly likely that the contents of the Mealworm passage reduced the disgust response towards the prospect of eating mealworm-containing falafels. The passage was designed to be affectively neutral (i.e., not add or subtract from the disgust generated by the initial statement that the falafel contained mealworm flour) but may have primed both the **cooking process** and the **familiarity** of the ingredients in the falafel. It described how mealworm flour is produced which involves the mealworms being baked (cooking prime) and turned into flour (a familiar ingredient). The cooking process is very important for animal ingredients such as insects, as it transforms them from being inedible into appealing food (Deroy et al., 2015; Hamerman, 2016). Cooking also allows the animal ingredient to appear less animal like which is important as insects are more likely to be accepted when



their animal like properties are minimised (Hartmann et al., 2015). Eric Hamerman's (2016) study which found that among those who are low in trait animal reminder disgust, priming cooking increases willingness to go to an event where insects would be eaten, exemplifies the importance of cooking. He went on to claim that education about entomophagy would be more effective if coupled with a campaign to promote cooking in the home (Hamerman, 2016).

Familiarity is also important when reducing disgust because uncertainty about a food product drives neophobia and leads to rejection (Fallon & Rozin, 1983). Similarly, the results of the present study emphasise the negative effect of neophobic responses on food intake. If information about a product is given and it is incorporated into a familiar ingredient this can enhance its acceptance (Tuorila, Meiselman, Bell, Cardello, & Johnson, 1994). Based on this logic, by discussing how mealworms are transformed into mealworm flour, the Mealworm passage may have reduced the disgust response by increasing familiarity perception, hence the lack of difference in dependent measures (other than self-report disgust) in this condition compared to control. This finding supports previous studies that emphasise the importance of familiarity in food choices (e.g. Caparros Megido et al., 2016; Hartmann et al., 2015; Menozzi et al., 2017; Wilkinson et al., 2018).

To consider the possibility that the Mealworm + education passage *increased* feelings of disgust it is worth noting that explicit written descriptions relating to insect food are less preferred among consumers than more vague descriptions (Baker, Shin, & Kim, 2016). This is explained as being due to explicit descriptions making individuals more aware of insect ingredients which increases disgust and fear - more ambiguous descriptions may reduce this risk. As the Mealworm + education passage in the present study described the

rearing of mealworms supposedly included in the falafel, participants may have been too explicitly reminded of the novelty and risk associated with the food they were about to consume. This is one possibility, though not as likely as the contents of the Mealworm passage *reducing* disgust.

The question posed by the reduction in disgust in the Mealworm condition is at what point when reading the passage did disgust among those in the Mealworm + education condition exceed that in the Mealworm condition? The data shows that by the end of the passage feelings of disgust were higher in the Mealworm + education condition compared to the Mealworm condition and that the Mealworm condition did not differ to Control. There is no evidence to suggest that after reading the first paragraph in both mealworm conditions that negative emotions towards the food differed between the two groups as they had read identical words – therefore the change in affect occurred after this. It is unlikely that reading that first paragraph had *no effect* on emotions because for that to be the case the contents of the Mealworm + education passage would have needed to heighten disgust, as disgust was higher than control afterwards, but this is unlikely as it merely outlined the advantages of entomophagy. Furthermore, the results of Experiment One show that being asked to consume mealworm containing falafels *does* lead to the emotion of disgust and increases subjective discomfort. It can therefore be assumed that participants in both mealworm conditions experienced an equal level of disgust after reading the first paragraph. This level of disgust was then increased or decreased by the information given in the passage that immediately followed. Cooking and familiarity may have decreased disgust by leading to more positive ideation and the description of the hygienic conditions in which mealworms are reared (the ending of the Mealworm + education passage) may have failed to reduce disgust (or increased it) by reminding

participants of the *potential* for a lack of hygiene. The discussion of the sustainability and nutritional advantages of entomophagy may have led to more positive ideation, but not as much as cooking or familiarity, and/or those arguments were undermined by the description of hygiene. Further research is needed to provide clarity on this array of unknowns.

### **3.4.5 Future directions.**

Further avenues of research may employ techniques that can reliably answer the question of which specific aspects of the condition passages affected the disgust response in the Mealworm + education and Mealworm conditions. Electroencephalogram (EEG) could be used to investigate this. Due to its temporal specificity disgust reactions could be observed in real time as the participant is reading a passage of text. It has recently been used as an implicit method to understand participants' emotional experience when cooking and tasting insect containing food. EEG, along with electrocardiogram and skin potential variables, predicted with 82% accuracy whether a participant was cooking mealworms or chicken (Brouwer, Hogervorst, Grootjen, Erp, & Zandstra, 2017). A study with a similar design to the present one, but with the inclusion of an additional condition which outlines irrelevant information, may be useful in order to understand if the contents of the Mealworm + education passage had any positive effect. It might be the case that the disgust response towards the prospect of consuming mealworm falafels has the potential to be higher than what was displayed in the Mealworm + education condition – so it may have had an undetected positive effect that could be revealed by comparison to an irrelevant information condition.

Future research may also benefit from further investigating the use of cooking primes and emphasising the incorporation of insects into familiar foods in order to reduce the disgust response. It may be useful to isolate the effects of cooking and familiarity interventions (by including them as separate interventions in the same study) in order to understand their individual contribution to the reduction in disgust response and therefore focus future interventions.

Finally, future research may consider including food-related trait measurements such as the Food Technology Neophobia scale (FTN; adapted by Verbeke, 2015), the Food Disgust Picture Scale (Ammann, Hartmann, & Siegrist, 2018a, 2018b) or the Food Disgust Scale (Hartmann & Siegrist, 2018). This is to overcome the lack of specificity of the DS-R in the context of food related research. FTN has been found to be one of nine significant predictors of willingness to consume insects (Schlup & Brunner, 2018) and may therefore have moderating effects in future novel food-disgust studies.

#### **3.4.6 Limitations.**

The method of measuring tactile sensitivity was a limitation in this study. The monofilaments were not precise enough meaning changes in tactile sensitivity that were caused by small changes in force were not distinguishable. Perhaps future studies would be better placed by using more precise methods to measure tactile sensitivity which are less susceptible to human error. This study was also limited as the method used to induce threat was ineffective and therefore not an adequate control for general negative arousal. Furthermore, the method of assessing disgust and nervousness towards the tongue biopsy procedure in the Threat condition was limited by taking place after the participants in that

condition knew that the procedure was not going to take place. This may have led to reduced emotion intensity and consequently an inability to accurately report how they had previously felt. Finally, the method used to assess subjective feelings of threat was not the same as that used in Experiment One. In Experiment One a 10-point scale was used to rate 'discomfort', whereas in Experiment Two 'nervousness' and 'disgust' were both reported on a 100mm line anchored 'Not at all' and 'Extremely'. Furthermore, more information about the tongue biopsy procedure was given in Experiment Two which may have reduced apprehension. This makes comparing across the two studies difficult. Future studies may benefit from using a consistent measure of self-reported affective states in order to avoid this issue.

### 3.5 Conclusion

The results of this study support the conclusion that educational interventions based on rational arguments relating to the environmental and nutritional benefits of consuming mealworms are at least relatively ineffective at reducing the disgust response and increasing acceptance associated with entomophagy. This supports a wealth of literature which reaches the same conclusion, on the basis of self-reported attitudes, and strengthens these conclusions by showing these arguments are ineffective at maintaining actual food intake. The finding that trait food neophobia had moderating effects on falafel intake in the Mealworm + education condition supports previous research which investigated its moderating effect on willingness to consume insects and attitudes towards entomophagy. These results therefore extend previous findings to show the moderating effect persists with the behavioural measure of food intake. Further research into the usefulness of cooking primes and incorporating insects into familiar foods is recommended.

#### 4. General Discussion

This project aimed to first, develop an ecologically valid method to induce threat and second, investigate if educational interventions based on the nutritional and environmental benefits of consuming mealworms would reduce the disgust response associated with entomophagy. The first aim was achieved using a qualitative approach (thematic analysis) to understand the emotions induced and motivators/inhibitors in a given imagined scenario. The second aim was achieved using a novel research design that included implicit measures of disgust, rather than the more widely used explicit self-report measures, and quantitatively measuring the behaviour of food intake.

The results of Experiment One suggest that asking participants to eat mealworm-containing falafel leads to the emotion of disgust and telling them they will be required to have a tongue biopsy leads to the feeling of threat. Also, the intensity of these two states are equivalent. While it was initially hypothesised that these results would be obtained using a finger prick to induce threat, preliminary analysis suggested that this would not be the case – analysis that led to the development of the tongue biopsy method. Interestingly, the sub-theme of *past knowledge informing present* emerged from the Threat FP data and became a very informative dimension. It seems familiarity with the sensation of a finger prick reduced feelings of threat. This finding may be considered by future researchers when developing emotion induction methods – increased familiarity may lead to a reduction in emotion intensity. Notably, the sub-theme of *food neophobia* emerged from the Disgust condition. Many participants attributed their feelings of disgust and discomfort to having

never eaten mealworms before. This further emphasises the role of familiarity (or lack thereof) in emotion perception and extends it to food-related emotions.

Results from Experiment Two were not in-keeping with all of the hypotheses. Surprisingly, the largest disgust response was shown in the Mealworm + education condition rather than the Mealworm condition. This was on the basis of liking, DtE and falafel intake as there was no significant effect of condition on the two implicit measures (tactile sensitivity and LtE). Food neophobia was the only trait that predicted falafel intake in session two and there was an interaction between the Mealworm + education condition and food neophobia. The self-report data on disgust was interesting as the pattern of self-report disgust differed from the pattern that emerged from the measures of falafel intake, liking and DtE – participants in the Mealworm condition self-reported an equivalent level of disgust to those in the Mealworm + education condition despite them liking and desiring to eat the falafel more, and eating a larger amount. Lastly, the data on self-report nervousness in the Threat condition showed that participants may not have experienced threat when asked to have a tongue biopsy.

Taken together several conclusions can be drawn from Experiments One and Two. Despite the results of Experiment One suggesting that using the tongue biopsy method to induce threat would be effective, when implemented in a lab setting in Experiment Two, it seems that this method did not induce threat, perhaps in part because it was not believed. This shows the importance of verifying measures in a lab setting as reported emotions based on an imagined scenario were different to actually experienced emotions when the same method of reporting was used (Likert-type scales) – a finding that once again alludes to the Attitude-Behaviour Gap (Ajzen, 2001; Kraus, 1995). However, it is worth noting that



this interpretation is somewhat tentative as the same measurement technique to assess subjective threat was not used across the two experiments making it difficult to compare across studies.

Food neophobia emerged as an important trait in both studies. In Experiment One it was the concept used by many participants to explain their feelings of disgust towards mealworm-containing food. While in Experiment Two, trait food neophobia predicted falafel intake in session two. Together these results emphasise the emerging importance of this trait in food disgust research, and robustly support the wealth of previous literature that has highlighted its importance (e.g. Hartmann et al., 2015; Hartmann & Siegrist, 2016; La Barbera et al., 2018; Meiselman et al., 2010; Schlup & Brunner, 2018; Sogari et al., 2018; Verbeke, 2015; Wilkinson et al., 2018).

The role of familiarity on general, and food-related, emotions became apparent in both studies. Experiment One found that familiarity, or lack thereof, plays a role in the degree to which a negative emotion is experienced in relation to both threatening and disgusting stimuli. The results of Experiment Two suggest that emphasising the cooking process and increasing familiarity, thus normalising the novel ingredient, reduced the disgust towards mealworm-containing falafels. As both studies unexpectedly found familiarity to be a key concept, future research may consider this when investigating ways to reduce food-related disgust.

The findings of the present project lead to the conclusion that the educational intervention used did not decrease disgust towards mealworm-containing food. The data do not reveal if this was due to the sustainability and nutritional arguments leading to rumination on the insect ingredients or if it was due to the discussion of the hygienic

conditions in which mealworms are reared leading to doubts about cleanliness. Regardless, increasing public knowledge about the environmental impact of food choices may have a more general positive effect (Siegrist & Hartmann, 2019). The nutritional and environmental benefits of entomophagy are widely recognised as being important motivators to consume alternative proteins such as insects (Apostolidis & McLeay, 2016; Caparros Megido et al., 2016; Cicatiello et al., 2016; Lensvelt & Steenbekkers, 2014; Looy & Wood, 2006; Menozzi et al., 2017; Ruby et al., 2015; Schouteten et al., 2016; Sogari, 2015; Verneau et al., 2016), and this project does not refute that. Simply, these rational arguments, presented in the written form have not been found to solely reduce the disgust response towards mealworm-containing food, to the extent that people do not reduce their intake of the food. This finding is important as it supports the area of literature which states that emotions cannot be overcome with rationality, and suggests other areas should be further explored, such as increasing the familiarity of the novel food ingredient and emphasising the cooking process. These areas should be explored using a similar research design to Experiment Two by including implicit measures of disgust and measuring the amount of novel food consumed. In addition, a negative emotion control which is induced in an ecologically valid way should be included, along with a Mealworm + *irrelevant*-information condition in order to understand if the educational passage used in the present study had any positive effect.

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## **Appendix**

### **Appendix A: Questionnaires used in Experiment One**

**Please try to imagine yourself in this situation:**

You are in a lab room. You are told by the experimenter than at some point in the next 10 minutes you will need to eat falafels that are made from 50% chickpeas and 50% dried mealworm (insects) flour (pictured below).



Can you describe in detail how this would make you *feel*?

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Can you describe *why* it would make you feel like this?

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Would the prospect of eating mealworm flour falafels in a study affect your decision to participate in the study?  
(Please circle your answer)

Yes                      No                      Maybe

Can you explain your answer?

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Can you please rate on this scale what level of discomfort you would feel at the prospect of eating mealworm containing falafels. (1 = no discomfort at all, 10 = extremely uncomfortable) Circle your answer.

No discomfort at all	1	2	3	4	5	6	7	8	9	10	Extremely uncomfortable
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**Please try to imagine yourself in this situation:**

You are in a lab room. You are told by the experimenter that at some point in the next 10 minutes you will need to have a finger prick blood sample taken (pictured below). This will be done using a Finger Prick Kit.



Can you describe in detail how this would make you *feel*?

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Can you describe *why* it would make you feel like this?

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Would the prospect of a finger prick blood test in a study affect your decision to participate in the study? (Please circle your answer)

Yes                      No                      Maybe

Can you explain your answer?

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Can you please rate on this scale what level of discomfort you would feel at the prospect of giving blood through a finger prick sample. (1 = no discomfort at all, 10 = extremely uncomfortable) Circle your answer.

No discomfort at all	1	2	3	4	5	6	7	8	9	10	Extremely uncomfortable
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**Please try to imagine yourself in this situation:**

You are in a lab room. You are told by the experimenter than at some point in the next 10 minutes you will need to eat chickpea falafels (pictured below).



Can you describe in detail how this would make you *feel*?

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Can you describe *why* it would make you feel like this?

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Would the prospect of eating chickpea falafels in a study affect your decision to participate in the study? (Please circle your answer)

Yes                  No                  Maybe

Can you explain your answer?

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Can you please rate on this scale what level of discomfort you would feel at the prospect of eating chickpea falafels. (1 = no discomfort at all, 10 = extremely uncomfortable) Circle your answer.

No discomfort at all 1 2 3 4 5 6 7 8 9 10 Extremely uncomfortable

**Please try to imagine yourself in this situation:**

You are in a lab room. You are told by the experimenter than at some point in the next 10 minutes you will need to have a small, harmless biopsy (incision to obtain sample) on your tongue using a sterilised medical lancet.



Can you describe in detail how this would make you *feel*?

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Can you describe *why* it would make you feel like this?

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Would the prospect of having a tongue biopsy in a study affect your decision to participate in the study? (Please circle your answer)

Yes                      No                      Maybe

Can you explain your answer?

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Can you please rate on this scale what level of discomfort you would feel at the prospect of having a tongue biopsy (1 = no discomfort at all, 10 = extremely uncomfortable) Circle your answer.

No discomfort at all	1	2	3	4	5	6	7	8	9	10	Extremely uncomfortable
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Appendix B: Passage given to participants in the Control condition in Experiment two. N.B. Adapted from previous NBU undergraduate project. Online sources used to describe spice production.

### **Spice production**

In a few minutes you will be served a portion of world food that has been made differently to the one you ate in the first part of the experiment. This falafel contains different herbs and spices from the previous falafel you ate. The pitta bread is the same as before – it's made from white flour.

These falafels are inspired by an authentic middle eastern recipe. They are flavoured with middle eastern spices. These falafels are mainly made from chickpeas and a paste which includes dates, garlic puree, paprika, parsley, turmeric, cinnamon and ginger. The main herbs and spices in the falafels are coriander, cumin, oregano and garlic. They are made by blending these ingredients and are baked.

Moroccan cuisine has been influenced by other cultures and nations over the centuries. Spices are the defining point to any authentic Moroccan meal. Most traditional Moroccan dishes contain spices, but not just the run-of-the-mill spices you might find in your normal grocery store. In Morocco, fresh spices are the norm. The spices most important to Moroccan cuisine are: cinnamon, cumin, turmeric, ginger, pepper, paprika, sesame seeds, coriander saffron, oregano and cayenne pepper. Common herbs in Moroccan cuisine include: mint, parsley, coriander, peppermint, marjoram, caraway and sage.

Spices are distinguished from herbs, which are the leaves, flowers, or stems from plants used for flavouring or as a garnish. Sometimes, spices may be ground into a powder for convenience. Spices are usually used in small amounts and are best used dry. Producing spices can be a simple process. The root, bark, or whichever part of the plant (other than the leaves) that is being used is first dried. This can be done in the oven, a dehydrator or air dried. Once the plant extract is dry it can be crushed using a pestle and mortar or processed in a blender to produce a powder. Many commonly used spices can be made in this way.



Appendix C: Passage given to participants in the Mealworm condition in Experiment two. N.B. Adapted from previous NBU undergraduate project. Online sources used to describe cooking procedure.

### **Mealworm Flour**

In a few minutes you will be served a portion of world food that has been made differently to the one you ate in the first part of the experiment. The main ingredients of this falafel are 50% dried, ground **mealworms**, and 50% chickpeas. The pitta bread is the same as before – it's made from white flour.

Mealworms are commonly eaten insects. They are the larval form of the mealworm beetle and are typically 2.5cm in length. Mealworm flour consists of whole meal worms dried and ground into a fine powder.

The process of producing mealworm flour is fairly simple. Around 5000 mealworms make just over 256g of flour. Once the mealworms are dry they are put in an oven to be toasted. The mealworms are spread on a baking sheet and toasted in an oven set to 90 degrees Celsius for 1 hour and 45 minutes. They are moved every 30 minutes or so to gain the right browning and crunch. Once the mealworms are cooked and cooled they are put into a food processor. It can take a few minutes of blending and stirring to produce the final flour. Mealworm flour tends to be slightly more oily than traditional wheat flour.

Once you have obtained the mealworm flour it can be used to make the falafels. The mealworm flour can be used in conjunction with chickpeas or fava beans to make falafels. To make mealworm and chickpea falafels the mixture of chickpeas, herbs, oil and spices are blended together. Then the mealworm flour is incorporated into this mix. Once these ingredients are thoroughly infused the falafels are moulded to the desired size and shape. The falafels can then be cooked in one of two ways. Either they can be fried in oil for 3 minutes on each side or they can be baked in an oven at 170 degrees Celsius for 25-30 minutes and flipped half way through.

Appendix D: Passage given to participants in the Mealworm + education condition in Experiment two. N.B. Adapted from previous NBU undergraduate project.

### **Eating insects**

In a few minutes you will be served a portion of world food that has been made differently to the one you ate in the first part of the experiment. The main ingredients of this falafel are 50% dried, ground **mealworms**, and 50% chickpeas. The pitta bread is the same as before – it's made from white flour.

Mealworms are commonly eaten insects. They are the larval form of the mealworm beetle and are typically 2.5cm in length. Mealworm flour consists of whole meal worms dried and ground into a fine powder.

There are many advantages to eating mealworms – both for personal health benefits and for the sustainability of our planet. Mass production of mealworms has less environmental impact than mass production of cattle does. Mealworms produce lower amounts of green-house gases and less ammonia than cattle and require less land and water.

The health benefits are due to mealworms being nutritionally rich. They have a very high protein content including the essential amino acids. They also contain vitamins, minerals and fibre. Mealworms contain the same amount of omega 3 oils as fish – which are very good for brain function. Indeed, they are so nutritious that they can be used in emergency relief programmes in countries where people suffer from malnutrition.

Insects also pose benefits to the livelihoods of many. Mealworm harvesting is low-tech and doesn't require large investment in equipment so it can be done by even the poorest people in society. As insects are 'minilivestock' they can be reared by those who do not have much land including those who live in urban areas and those with less money.

Insects which are produced to be eaten by humans are of a high quality. They are reared under hygienic conditions isolated from wild insects. Their living conditions, diet, and food quality are carefully controlled. Mealworms are farmed in large quantities. Their diets can be altered to increase their nutritional value.

Appendix E: Passage given to participants in the Threat condition in Experiment two. N.B. Adapted from previous NBU undergraduate project. Online sources used to describe tongue biopsy procedure.

### **Tongue Biopsy**

In a few minutes you will be served a portion of world food that has been made differently to the one you ate in the first part of the experiment. This falafel contains different **herbs and spices** from the previous falafel you ate. The pitta bread is the same as before – it's made from white flour.

We are interested in investigating how your enjoyment of this falafel is affected by your taste buds (sensory organs found on the tongue). They allow you to taste sweet, salty, bitter and sour things. Humans have on average 10,000 taste buds which are replaced every 2 weeks. As you get older it can be more difficult for you to taste certain flavours. This is because as we age the number of taste buds we have reduces - this decline usually starts from 40 to 50 years old.

In order to investigate how your taste buds affected your enjoyment of falafel, after you have finished eating the falafel we will take a sample of your taste buds by carrying out a harmless tongue biopsy (incision to obtain sample).

The equipment that will be used for this tongue biopsy is a sterilised medical needle device and a petri dish to contain the sample. The tissue is then examined under a microscope.

At the end of testing in this room I will take you to a clinic room in this building where my colleague Victoria, a professionally trained nurse, will take the tongue biopsy. She is very familiar with the procedure.

How the test is performed:

- The procedure takes no more than 10 minutes
- The nurse will gently stick the needle into your tongue and remove a small piece of tissue
- As we will be taking just a small sample of taste buds no numbing cream at the location of the biopsy will be needed
- You should feel no more than a pin prick on your tongue

Appendix F: Table of nutritional information for all the foods used in Experiment Two and manufacturer's addresses.

Food	Nutritional component per 100g			
	Energy (Kcal)	Fat (g)	Carbohydrate (g)	Protein (g)
Original Cauldron Falafels	239	6.5	36.0	6.0
Moroccan Spiced Cauldron Falafels	268	14.0	25.0	7.5
Gosh! Original Falafels	239	10.4	32.7	6.8
Gosh! Moroccan Spiced Falafels	291	17.5	27.7	10.2
Sainsbury's White Pitta Bread	275	1.2	54.7	9.8

Sainsbury's limited:

No 2 Lochrin Square, 96 Fountainbridge, Edinburgh, EH3 9QA

Cauldron Foods limited:

Quorn Foods, Station Road, Stokesley, North Yorkshire, TS9 7AB

Gosh! Food limited:

C/O Grant Thornton Kingfisher House 1 Gilders Way, St James Place, Norwich, Norfolk, NR3 1UB

Appendix G: Table showing the descriptive statistics (mean and standard deviation), after participant exclusions, of each dependent measure for all four conditions in Session one and Session two of Experiment Two.

Dependent Measure		Condition							
		Control		Mealworm		Mealworm + education		Threat	
		M	SD	M	SD	M	SD	M	SD
Falafel Intake (g)	Session one	111.3	49.4	126.6	46.9	107.3	56.6	97.4	42.1
	Session two	125.7	54.1	114.5	61.7	72.0	49.7	108.6	45.8
Pitta Intake (g)	Session one	46.4	26.2	47.0	26.7	33.3	21.5	37.0	24.5
	Session two	41.1	27.6	46.1	29.8	37.3	25.2	39.4	30.7
Tactile sensitivity (g)	Session one	.0877	.1083	.0857	.1342	.0989	.2004	.0562	.0445
	Session two	.0901	.1236	.0579	.0525	.0775	.1320	.0712	.0837
LtE (ms)	Session one	4.17	2.87	3.85	3.23	3.92	3.46	3.79	1.85
	Session two	3.78	1.84	4.43	3.19	5.01	2.02	4.20	3.24
Liking falafel (max = 100)	Session one	64.6	17.6	72.4	20.1	65.5	19.6	67.6	16.8
	Session two	71.4	19.8	71.1	15.2	54.7	20.6	69.19	18.1
DtE falafel (max = 100)	Session one	62.4	22.9	68.5	17.9	53.5	29.1	59.8	28.3
	Session two	73.0	16.3	65.8	17.6	45.6	21.1	61.7	26.1
Liking Pitta (max = 100)	Session one	49.0	22.9	52.5	19.4	48.3	21.6	46.9	15.7
	Session two	47.0	20.5	52.5	18.9	51.9	18.5	46.9	15.0
DtE Pitta (max = 100)	Session one	43.5	26.1	55.4	19.0	37.0	24.5	41.7	23.2
	Session two	44.1	23.8	51.3	18.5	44.0	22.8	43.1	23.0

Appendix H: Table showing descriptive statistics (mean and standard deviation) for the various participant trait measures.

Trait	Group									
	Whole cohort		Control		Mealworm		M + E		Threat	
	M	SD	M	SD	M	SD	M	SD	M	SD
BMI	23.49	3.59	22.69	3.65	23.96	4.05	24.15	3.51	23.16	3.11
DS	12.10	3.20	11.33	3.55	12.29	3.40	11.85	2.77	12.94	2.98
SS	20.34	6.02	19.73	6.43	21.31	6.33	21.50	5.49	18.81	5.69
FN	22.24	9.22	21.00	7.23	21.81	10.10	24.12	9.93	22.04	9.59
EE	2.42	.75	2.42	.74	2.34	.57	2.45	.99	2.48	.67

*Note.* BMI = Body Mass Index (kg/m<sup>2</sup>); DS = Disgust Sensitivity (possible score range 0 – 25); SS = Sensation Seeking (possible score range = 0 – 39); FN = Food Neophobia (possible score range 10 - 70); EE = Emotional Eating (possible score range 1 – 5).